# Open Lake Disposal (Sediment and Water Quality Evaluation)

**APPENDIX B2**

**SUB-COMMITTEE**

**FINAL STUDY PLAN**

U.S. Army Engineer District, Buffalo • 1776 Niagara Street • Buffalo New York 14207

# FINAL

# STUDY PLAN

# EVALUATION OF THE EFFECTS OF DREDGING AND PLACEMENT OF DREDGED MATERIAL FROM TOLEDO HARBOR

**U.S. Army Corps of Engineers**
**Buffalo District**
**Buffalo, New York**

**And**

**U.S. Army Corps of Engineers**
**Engineer Research and Development Center**
**Waterways Experiment Station**
**Vicksburg, Mississippi**

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# Introduction

## Background

The Long Term Management Strategy (LTMS) developed for Toledo Harbor requires the evaluation of management alternatives for maintaining navigation, which includes the dredging and placement of the navigation channel sediment in appropriate sites. The Buffalo District is authorized to maintain navigation in the Toledo Harbor from River Mile 7 to Lake Mile 16 under its operation and maintenance program (O&M). The evaluation of the effects of dredging and placement activities under the O&M authority should follow the USEPA/USACE Technical Framework (USEPA/USACE 1992), the Inland Testing Manual (USEPA/USACE, 1998), and The Great Lakes Dredged Material Testing and Evaluation Manual (1997). As such, available information on the sediment in the channel (quantity, bulk chemical analyses, etc), point discharges into the Maumee river, adjacent land use, etc. is considered to answer the question "Is there reason to believe the sediment in the navigation channel is contaminated?" Based on available information and past sediment chemical data and testing, there was concern and reason to believe contaminants are present in the sediments of the Toledo Harbor. Therefore, this study plan is being developed to address the testing of channel sediments and the concerns raised about the dredging and placement of the sediment from the navigation channel and concerns raised about sediments adjacent to the navigation channel. The U.S. Army Corps of Engineers Buffalo District is authorized to dredge and maintain the channel to the authorized depth. In order to accomplish this responsibility, the District evaluates the effects of dredging and placement of dredged material according to the Clean Water Act, Section 404 and NEPA regulations.

## Scope

The study plan addresses concerns raised in relation to the dredging and placement of dredged material from the Toledo Harbor. It contains a detailed sampling and physical, chemical and biological testing plan for sediment prior to the 1999 dredging process. Many concerns raised during the development of the study plan have been addressed in the study plan. Initial testing will be conducted in 1999. Based on the results of those tests, further evaluation may be conducted in future years. All concerns presented have been addressed in Appendix A.

# Sediment Collection and Characterization

A sampling plan has been developed to obtain data for the evaluation of the effects and placement of dredged material from Toledo Harbor. Sampling of the Toledo Harbor sediments and water at the open-lake disposal operation area are proposed to satisfy the data requirements for the evaluation. Certain sampling and testing falls under the funding authority of the O&M program while other sampling and testing go beyond that authority and will require other funding sources such as the LTMS, etc.

## Sediment Collection

Since the Federal maintained shipping channel for the Toledo Harbor is dredged on an annual basis and approximately up to three feet of deposited sediment is removed annually, sediment surface grab samples should be appropriate for collection and analyzed before the annual maintenance begins in late spring 1999. A surface grab sample (a composite of 3 grab samples within 10 feet of the location) will be taken for sediment analyses at every River Mile (RM-7 to RM-1, 7 samples) and Lake Mile (LM-0 to LM-16, 17 samples) in the Federal channel. These sites are shown in Figures 1 & 2. Three (3) sediment surface grab samples will be taken at the current disposal area and three (3) sediment surface grab samples will be taken at a suggested open-lake reference area (background). These sample locations are shown in Figure 3. Reference sites for test comparisons are usually located in the environs of the disposal site. The Clean Water Act specifies the evaluation of adverse impacts to the disposal site environs. Therefore, reference sites near the disposal site and whose sediments are of similar physical characteristics as the dredged material should be selected for test comparisons. A suggested reference area is shown in Figure 3, south of the navigation channel at about Lake mile 11.

Channel sediment samples should be representative of the approximate layer of material proposed for removal. These samples are appropriate under the O&M funding authority.

In addition, a sediment surface grab sample (a composite of 3 grab samples within 10 feet of each other) will be taken at every mile interval starting at RM-0.5 to LM-6.5 (8 samples). The locations are shown in Figure 4. These samples will provide additional resolution for sediment characterization, but are beyond the funding authority of the O&M program and will require other funding sources such as the LTMS, etc.

Using sediment core samples rather than surface grab samples for sediment characterization analyses is a possibility. The distribution of contaminants in sediments that are dredged annually usually do not show measurable differences in concentration with sediment depth unless a point source discharge or spill occurred during the year following the previous dredging. Differences in contaminant concentrations are more likely to be measured in channels that have not been dredged for long periods of time, such as 10 or more years. In this case, layers of different contaminant concentrations may be easily measured. This is not the case in Toledo Harbor that requires dredging each year.

Three types of dredges could be used in Toledo Harbor, hydraulic pipeline, mechanical clamshell or hopper dredge. Usually the sediment is removed to the depth of dredging as much as possible. Consequently, the dredging process removes the entire depth of sediment to be dredged. Hydraulic dredging thoroughly mixes the sediment as it passes through the dredging discharge pipe and is placed in a confined disposal facility or a barge for transport to the open water placement site. Clamshell dredging places the entire depth of sediment to be dredged in a barge for transport to the placement site. The clamshelled dredged material in the barge is usually slurried with water prior to placement in the CDF. At the open water site sediment from the clamshell operation can also be slurried prior to placement or in some cases can be placed without being slurried. The contractor's equipment will determine what method is used. Whatever equipment is used, any small differences that might have occurred in contaminant concentrations with sediment depth will disappear during the dredging process. Therefore sediment cores and the resultant data are impractical and of little value.

To address concerns on sediment quality outside the lake channel, surface grab samples will be collected at locations LM-3, LM-5, LM-8, LM-10, and LM-15, approximately 200 feet out from the channel edge on each side of the channel as shown in Figure 5. However, this is outside the authority for the normal O&M program as authorized by Congress. Therefore, other funding such as the LTMS, etc., would be required to accomplish this evaluation.

**Side slope exposure.** To address concerns related to the exposure of contaminants on the channel slopes following dredging, limited focused sampling will be conducted based on a recent report entitled "Screening Analysis Sediment Quality Assessment Study of the Maumee River Area of Concern, 1995 &1996, Lucas and Wood Counties by ASci Corporation for the Ohio EPA (ASci Corporation, 1998). Some locations in the Maumee River, particularly MR 56 showed elevated sediment concentrations of lead and zinc on the side slope of the channel. Additional sediment sampling will be conducted to further characterize the potential for exposure of channel side slope contaminants at this location. An example of a sampling design might be to collect three grab samples at each of the top, middle, and bottom of the side slope following dredging of the river. These samples should indicate what is being exposed along the slope. Chemical analysis of the sediment samples for lead and zinc as well as toxicity and bioaccumulation bioassays will be conducted. An alternative design for sampling could be to sample three different transects down the slope. For example, at one location along the river at MR 56, sample the top, middle and bottom side slope. Then move ten feet down river and resample the top, middle, and bottom side slope. Repeat the procedure at a location ten feet further down river to give three different transects at three slightly different locations at or near MR 56.

## Sediment Characterization and Analysis

Each sample is to be analyzed for the following parameters with the specified EPA methods and detection limits where appropriate:

| Parameter | Analytical Method | Preparative Method | Detection Limit |
|---|---|---|---|
| Metals* | 6010A/7000A | 3050A | < 120-800 ppb |
| PAHs | 8270C | 3550 | < 250-500 ppb |
| Pesticides** | 8081A | 3550 | < 33 ppb |
| PCB | 8082 | 3550 | < 100 ppb |
| Oil & Grease | 413.2 | | < 25 ppm |
| Chemical Oxygen Demand | 410.4 | | < 100 ppm |
| Total Organic Carbon | 415.1 | | < 25 ppm |
| Total Cyanide | 335.2 | | < 0.5 ppm |
| Total Phosphorus | 365.4 | | < 1 ppm |
| Total Kjeldahl Nitrogen | 351.1 | | < 1 ppm |
| Ammonia | 350.1 | | < 1 ppm |
| Nitrate & Nitrite anions+ | 300.0 | | < 1 ppm |
| Grain Size | ASTM D422 | | |
| Total Volatile Residue | 160.4 | | |

*Antimony, Arsenic, Beryllium, Cadmium, Chromium, Copper, Cyanide, Lead, Mercury, Nickel, Selenium, Silver, Thallium, and Zinc (The Greeley-Polhemus Group, Inc. 1998,Table 5.2).
** including Chlordane
+Holding time is less than 48 hours

All laboratory analytical limits must be agreed on by all agencies.

## Quality Assurance/Quality Control

Split samples will be taken for QA/QC purposes. For internal laboratory quality control 5 sediment samples, 4 elutriate samples, and 14 water samples will be analyzed. For quality assurance purposes, 3 sediment samples, 2 elutriate samples, and 7 water samples will be analyzed by the Corps of Engineers quality assurance laboratory in Omaha.

Samples will be analyzed for:

Metals
PAHs
Pesticides & PCBs

For analytical limits see above.

## Biological Testing and Assessment

### Background

Sediments serve as sinks for many anthropogenic contaminants in the environment. Over the past 30 years, attention has shifted from concerns over water pollution (as control measures enacted in the 70's and 80's have resulted in a steady improvement in surface water quality) to contaminated sediments as a potential source of continuing environmental contamination. Beginning in the late 1960's, the U.S. Environmental Protection Agency (USEPA) and the U.S. Army Corps of Engineers (USACE) used sediment physical and chemical properties to render decisions regarding discharges to the Great Lakes. Initial assessments of freshwater and marine dredging projects involved the evaluation of seven sediment parameters with regulatory decisions predicated on chemical numerical levels (U.S. Army Corps of Engineers, 1972). In the 1970's, USEPA and the USACE adopted an effects-based testing approach where biological tests were employed to assess the potential impact of dredged material on the environment. Biological tests (i.e., bioassays) are important because they have the ability to integrate the potential ecological effects of contaminants present in a complex sediment matrix (i.e., contaminant bioavailability and toxicity) (Engler, 1980). Effects-based testing is designed to evaluate the acute and chronic toxicity of sediment-associated contaminants and to estimate their potential to bioaccumulate in the tissues of aquatic biota (U.S. Army Corps of Engineers, 1976 and USEPA/USACE 1977).

### Technical Approach

The Greeley-Polhemus Group, Inc. (1998) reported that an abundance of data associated with the dredging of Toledo Harbor and the open lake disposal of dredged material has been accumulated. However, many of the results from those toxicity studies have been termed "inconclusive". The Greeley-Polhemus Group, Inc. (1998) as the primary reason for the inconclusive results cited the lack of a standardized procedure for conducting bioassays and identifying ecologically relevant endpoints. Based on the information gathered to date, the following sampling plan is expressly designed for Toledo Harbor dredging projects and will consist of three components: Acute Toxicity Tests, Chronic Toxicity Tests, and Bioaccumulation Tests. Moreover, it is consistent with biological testing guidelines proposed in "Evaluation of Dredged Material Proposed for Discharge in Waters of The U.S. - Testing Manual" (USEPA/USACE 1998) (i.e., Inland Testing Manual) and the "Great Lakes Dredged Material Testing and Evaluation Manual" (1997). The recommended bioassays are designed to evaluate the potential for water column toxicity, benthic toxicity, and benthic bioaccumulation. Furthermore, the recommended bioassays are well documented and have been generally accepted by the scientific and regulatory communities. Environmental risks associated with dredged material disposal activities are evaluated by determining the toxicity of sediments in elutriate and solid phases in addition to the potential for contaminant bioaccumulation.

### Bioassays

The toxicity of sediments from the Toledo Harbor will be determined by conducting acute and chronic sublethal sediment bioassays on samples collected in the Maumee River, Lake Channel, Lake Disposal, and Open Lake Reference site. The toxicity of elutriates from these sites will be evaluated using the *Daphnia magna* and *Pimephales promelas* acute toxicity tests (USEPA, 1994) and whole sediment toxicity will be evaluated using the *Chironomus tentans* and *Hyalella azteca* chronic toxicity tests (ASTM, 1993). Bioaccumulation of chemicals from sediments will be evaluated via the *Lumbriculus variegatus* bioassay.

Ten channel samples, three disposal site samples, and three reference area samples will be tested. Sediments will be collected at the same time the samples in the *Sediment Collection* section are obtained. The reference samples and disposal site samples will consist of a three random grab samples each. The channel sediment samples to be tested consist of a sample from LM-13, a sample from LM-10, and eight composite samples from other channel reaches as described below.

Equal sediment amounts from the following locations are to be composited for each of the eight biological samples: (RM-1, RM-0.5, LM-0); (LM-0, LM-0.5, LM-1); (LM-1, LM-1.5, LM-2); (LM-2, LM-2.5, LM-3); (LM-3, LM-3.5, LM-4); (LM-4, LM-4.5, LM-5); (LM-5, LM-5.5, LM-6); (LM-6, LM-6.5, LM-7). These areas are illustrated in Figure 6.

**Elutriate Preparation.** Elutriates will be prepared in accordance with USEPA/USACE 1998, (Evaluation of Dredged Material Proposed for Discharge in Waters of the U.S. Testing Manual-Inland Testing Manual). In general, elutriates are prepared by subsampling dredged material from a composite sample and mixing that sample with unfiltered site water at a sediment to water ratio of 1:4. The mixture is then vigorously stirred and allowed to settle. The resulting supernatant is siphoned off and used in aquatic toxicity tests. For a detailed protocol describing elutriate preparations for the toxicity tests recommended herein, the reader is referred to the Great Lakes Dredged Material Testing and Evaluation Manual (1997).

**Test Sediments.** A detailed sampling plan to collect sediments from the Toledo Harbor study site is provided above. Samples will be selected to represent a range in toxicities. Negative control and reference sediments will be evaluated concurrently with Toledo Harbor samples. The negative control will be the laboratory culture substrate. Reference sediments will be selected to represent the range in grain sizes in the study area. Reference sediments will be environmentally similar to study site samples.

The sediments used for these tests will be analyzed for the following before testing:

| Parameter | Analytical Method | Preparative Method | Quantitation Limit |
|---|---|---|---|
| Metals | 6010A/7000A | 3050A | < 120-800 ppb |
| Pesticides | 8081A | 3550 | < 33 ppb |
| PCBs | 8082 | 3550 | < 100 ppb |
| PAHs | 8270C | 3550 | < 250-500 ppb |
| TOC | 415.1 | | < 25 ppm |
| Grain Size | ASTM D422 | | |

**Test Species.** For acute water column (elutriate) toxicity tests, two organisms: the cladoceran *Daphnia magna* and the fathead minnow *Pimephales promelas* are recommended. *Daphnia magna* is a planktonic freshwater cladoceran of the family Daphnidae. *D. magna* has been used to evaluate sediment quality in both acute and chronic exposures to elutriates, organic solvent extracts of sediment samples, whole sediments and pore-waters (Great Lakes Dredged Material Testing and Evaluation Manual 1997) (GLTEM). Historically, experiments using *D. magna* have had test durations ranging between 2 and 21 days. More descriptive information regarding the use of *D. magna* in elutriate bioassays can be found in Appendix G of the Great Lakes Dredged Material Testing and Evaluation Manual (1997).

The fathead minnow, *Pimephales promelas* is a freshwater fish of the family Cyprinidae. *Pimephales promelas* has been selected as a test species because it is relatively easy to culture, is widely distributed, ecologically relevant, and has been demonstrated to be sensitive to a variety of contaminants (GLTEM 1997). This species also is tolerant of a wide range in temperatures in addition and other physical and natural chemical conditions. More descriptive information regarding the use of *P. promelas* in elutriate bioassays can be found in Appendix G of the Great Lakes Dredged Material Testing and Evaluation Manual (1997).

For the evaluation of whole sediments in chronic toxicity tests, two organisms are recommended: the midge *Chironomus tentans* and the amphipod *Hyalella azteca*. *Chironomus tentans* is a non-biting midge of the family Chronomidae. It is widely distributed and is commonly found in eutrophic ponds and lakes (Townsend et al. 1981). *C. tentans* is ecologically relevant because it is a favorite food source for various fishes and waterfowl (Driver et al. 1974, McLarney et al. 1974). *C. tentans* is recommended as a test species because it is easy to culture, sensitive to certain classes of contaminants (e.g., pesticides), is easy to handle, and maintains close association with sediments. Appendix G of the Great Lakes Dredged Material Testing and Evaluation Manual (1997) provides more detailed information about this organism.

*Hyalella azteca* is a freshwater crustacean of the family Talitridae. *H. azteca* is widely distributed in North and South America (Pennak 1989). *H. azteca* is recommended as a test organism because of its ecological relevance, easy to culture, rapid growth, demonstrated sensitivity to a variety of contaminants, and close association with sediments. This species has also been found to tolerate a broad range in temperatures (0 to 33°C), substrate conditions (90% silt to 100% sand), and water conditions in which dissolved oxygen ranged from stagnant to saturated (Great Lakes Dredged Material Testing and Evaluation Manual 1997). More specific information about the life history of *H. azteca* can be found in Appendix G of the Great Lakes Dredged Material Testing and Evaluation Manual (1997).

Only one organism (*Lumbriculus variegatus*) is recommended for use in evaluating bioaccumulation of sediment-associated contaminants. *Lumbriculus variegatus* is a freshwater oligochaete that inhabits a variety of sediment types throughout the United States and Europe (Brinkhurst 1986). *L. variegatus* typically resides in the aerobic zone of sediments in lakes, reservoirs, rivers, and ponds. *L. variegatus* feed by ingesting sediment while tunneling. This species has been successfully used in water-only exposures (Nebeker et al. 1989; Ankley et al. 1991 a, b) and sediment exposures (Nebeker et al. 1989; Ankley et al. 1991 a, b, 1992b,c; and West et al. 1993). Laboratory bioassays using *L. variegatus* have been field validated with natural populations of oligochaetes by Ankley (1992a). *L. variegatus* is recommended as an appropriate animal model for bioaccumulation studies because it is relatively easy to culture, maintains intimate contact with sediment, provides adequate tissue mass for trace chemical analysis, tolerates a wide range in sediment physico-chemical conditions, and is amenable to long-term exposures. Appendix G of the Great Lakes Dredged Material Testing and Evaluation Manual (1997) contains more specific information on *Lumbriculus variegatus* life history and utility.

**Acute Bioassays.** The water column (elutriate) toxicity test for the cladoceran *Daphnia magna* will be conducted under static conditions at 20°C ± 1°C with no renewal of test water. The recommended photoperiod for the 48-h bioassay is 16-h/8-h light/dark at an intensity of 540-1080 lux. The Great Lakes Dredged Material Testing and Evaluation Manual (1997) (GLTEM) recommends conducting a 100% elutriate tests prior to performing the 48-h bioassay using a dilution series. The dilution series should only be considered if survival is less than 50% in the 100% elutriate. The test will be performed with neonates less than 24-h old with five animals per test chamber and five replicates per elutriate concentration/dilution. Test chambers should not be smaller than 30 mL in size and contain a minimum volume of 25 mL of elutriate. Aeration is provided only if dissolved oxygen (DO) drops below 40% saturation. Water quality should monitored daily with measurements of temperature, DO, hardness, alkalinity, specific conductance, pH, and total ammonia. The only endpoint measured following the acute exposure is survival. No feeding is required during this bioassay. Results of the acute bioassay are not considered acceptable unless control survival meets or exceeds 90%. A detailed protocol for the 48-h elutriate bioassay using *D. Magna* can be found in the Great Lakes Dredged Material Testing and Evaluation Manual (1997). The GLTEM also provides a detailed summary of dredged material and water volumes required for preparing a complete dilution series.

The acute elutriate toxicity test (i.e., 96-h) using the fathead minnow *Pimphales promelas* will be conducted under static conditions with daily elutriate renewals. The Great Lakes Dredged Material Testing and Evaluation Manual (1997) recommends conducting a 100% elutriate test prior to performing the 96-h bioassay using a dilution series. The dilution series should only be considered if survival is less than 50% in the 100% elutriate. The water temperature for this bioassay will be 25°C ± 1°C with a light intensity of 540-1080 lux. The photoperiod will be 16-h/8-h light/dark using animals 24-48-h old. Test chamber minimum size will be 250 mL and contain a minimum volume of 200 mL elutriate. Survival is the endpoint measured with test acceptability at 90% in control chambers. Information regarding basic bioassay design and optimal conditions for conducting the 96-h elutriate bioassay with the fathead minnow can be found in the Great Lakes Dredged Material Testing and Evaluation Manual (1997). The GLTEM also provides a detailed summary of dredged material and water volumes required for preparing a complete dilution series.

**Chronic Bioassays.** The test duration for whole sediment bioassays using *Chironomus tentans* is 10-d. Tests are initiated with animals younger than the third instar. Endpoints to be evaluated following the 10-d sediment exposures are survival and growth (dry weight). Control sediment survival of 70% or greater is the performance criterion. Clean control sediment will be used in the toxicity test and evaluated simultaneously with reference sediment samples and dredged material. Ideally, control, dredged material, and reference sediment samples should have similar physical properties (e.g., particle size and organic carbon). Control sediments serve as a barometer of biological performance and as criteria for determining test acceptability. Five laboratory replicates will be tested for each sediment sample. A detailed protocol for evaluating potentially contaminated sediments with *C. tentans* can be found in the GLTEM.

Whole sediment toxicity tests with the amphipod *Hyalella azteca* will have a test duration of 10-d. Test acceptability is determined by control survival of 80% or greater with DO levels of 40% or greater. Endpoints measured following the 10-d exposure to sediments will be survival and growth (dry weight). Animals at test initiation will be 7 to 14 days of age. Clean control sediment will be used in the bioassay and evaluated simultaneously with sediment samples from the proposed dredging and disposal sites. Ideally, control, dredged material, and reference sediment samples should have similar physical properties (e.g., particle size and organic carbon). Control sediments serve as a barometer of biological performance and as criteria for determining test acceptability. Five laboratory replicates will be tested for each sediment sample. A detailed protocol for evaluating potentially contaminated sediments with *C. tentans* can be found in the GLTEM.

**Bioaccumulation Bioassay.** Bioaccumuation tests will be conducted with the oligochaete *Lumbriculus variegatus.* These bioassays should have a duration of 28-d and a minimum of five replicates for each sediment sample evaluated. Overlying water is renewed at a rate of two volume exchanges per day. All sediments are thoroughly homogenized prior to their addition to the test chambers. Once added, these sediments are allowed to settle for 24-h prior to the addition of animals. The *L. variegatus* bioaccumulation test is considered acceptable if a sufficient mass of organisms is available following 28-d of exposure to the potentially contaminated sediments. Also, animals will be observed burrowing into the sediment at test initiation. Dissolved oxygen levels should remain at greater than 40 percent of saturation throughout the test. The GLTEM provides a detailed protocol for conducting bioaccumulation tests with this species.

A sample of test organism tissues before test initiation and the replicates after test completion are to be analyzed for:

| Parameter | Analytical Method | Preparative Method | Quantitation Limit |
|---|---|---|---|
| Metals | 6010A/7000A | 3050A | < 120-800ppb |
| Pesticides | 8081A | 3550 | < 33 ppb |
| PCBs | 8082 | 3550 | < 100 ppb |
| PAHs | 8270C | 3550 | < 250-500 ppb |
| Lipid Content | Analytical method calibrated against Chloroform/methanol extraction | | |

### Statistical Design And Analysis Of Sediment Bioassays

The bioassay and sediment sampling plan described above should generate exposure-response relationships. All statistical analysis and data transformations will be done using standard statistical software (e.g., SAS, Systat, and SigmaStat). Data will be screened for normality and homogeneity of variance via residual plots and Bartlett's test, respectively. Sediment toxicity will be evaluated via ANOVA or other appropriate models commensurate with the sediment sampling plan. If the F statistic is significant, mean separation will be performed using a Tukey's HSD test. All tests for significance will be analyzed at a significance level of $\alpha$=0.05. Both the Great Lakes Dredged Material and Evaluation Manual and the Inland Testing Manual (USEPA/USACE 1998) have detailed sections on data reporting and statistical analysis.

Section 6 of the Inland Testing Manual (USEPA/USACE, 1998) provides guidance for assistance in reaching factual determinations from data analyzing contaminant concentrations in tissues of organisms exposed to dredged material. In the event that toxicity and/or bioaccumulation tests results are judged to be inadequate to reach factual determinations, Tier IV evaluations on a case by case basis should be used. Section 7 of the Inland Testing Manual (USEPA/USACE, 1998) provides specific guidance on utility and application of chronic sublethal toxicity tests and bioaccumulation tests in Tier IV.

### Quality Assurance/Quality Control

**General.** Quality Assurance (QA)/Quality Control (QC) procedures for the sediment bioassays discussed in this sampling plan should follow the general guidance developed by Moore et al. (1994). The document entitled "Quality Assurance/Quality Control Guidance for Laboratory Dredged Material Bioassays" offers guidance on subjects (e.g., data quality objectives; biological procedures; data recording; internal quality control checks; and corrective action) and the procedures recommended therein are supported by the Great Lakes Dredged Material Testing and Evaluation Manual (1997) and the Inland Testing Manual (1998).

**Good Laboratory Practice.** Good laboratory practice, as set forth in appropriate guidelines and standards (ASTM 1988, 1992), will be followed. Acceptable water quality will be maintained during bioassays. These data should be reported to the District. Transfer of all animals will be via pipette or soft natural hair brush. Direct human contact will be avoided. Individual experiments will be partitioned from other laboratory activities and have individual temperature and photoperiod controls. Data will be recorded with indelible ink in bound laboratory notebooks assigned to the individual experiments and instrumentation. Laboratory personnel should sign and date all notebook entries. Hardcopy data entries will be transferred to computer data files on a routine basis with subsequent tape backup.

**Control Sediment- (Negative Control).** The negative control sediment for all solid phase toxicity tests will be the substrate in which the animal is cultured. This sediment will be thoroughly characterized (i.e., bulk chemical analyses, pore water ammonia, total kjeldahl nitrogen, grain size, etc.).

**Standard Operating Procedures (SOPs).** It is imperative that consistency be maintained in toxicological testing and reporting upon the completion of dredging projects. In order to ensure project continuity, laboratory SOPs will be written for all dredging related activities and periodically reviewed by the District. Moore et al. (1994), provides detailed examples of quality control checklists, project schedule lists, procedural checklists, test and reference control procedures, setup forms, test observation forms, and test termination forms for biological testing during dredging projects.

**Standard Reference Toxicity Tests- (Positive Control).** Reference toxicant tests using such chemicals as cadmium chloride, potassium chloride, and sodium chloride will be conducted inconjunction with each bioassay to assess the overall viability and sensitivity of the test organisms. Results of the reference toxicant test will be within 2 standard deviations of the mean of all previous reference tests with that animal and presented in control chart format. A minimum of five reference toxicant tests will be performed prior to any evaluations of dredged material or disposal site sediments (USEPA 1994). Results of the reference toxicant tests will be evaluated by developing a control chart that depicts the organism's $LC_{50}$ response (Moore et al. 1994). Reference toxicant tests should have a duration of at least 48-h with five replicates per toxicant concentration. Nominal reference toxicant concentrations will be confirmed analytically. Data from reference toxicant tests must be included with report.

**Culturing Test Organisms.** Culturing protocols have been developed for *Pimephaeles promelas*, *Chironomus tentans*, and *Lumbriculus variegatus*. Detailed descriptions of these protocols can be found in the Great Lakes Dredged Material Testing and Evaluation Manual (1997).

**Test Sediment Storage.** Sediment samples should be stored in the dark at 4°C and used in toxicity tests as soon as possible. Sediments stored under these conditions can be held up to six weeks prior to their use in toxicity tests. Since the test organisms are indigenous to the study area, sediment samples may have to be pre-sieved or frozen to eliminate potential bias in the data collected during the toxicity tests.

**Elutriate Storage.** Elutriate samples should be stored in the dark at 4°C and used in toxicity test as soon as possible. Elutriates stored under these conditions can be held up to six weeks prior to their use in toxicity tests.

# Water Quality Evaluation

## Elutriate Testing

Eluriate testing will be conducted on each of the sediment samples described in the *Sediment Collection* section above. Water for the elutriate testing will be obtained from the disposal area. This water will be chemically analyzed for the same parameters as the elutriates. Parameters and EPA methods are:

| Parameter | Analytical Method | Preparative Method | Detection Limit |
|---|---|---|---|
| Metals | 6010/7000 | 3010A/3020A | < 1 ppb |
| PAHs | 8310 | 3550 | < 2 ppb |
| Pesticides & PCBs | 8081A | 3550 | < 0.1 ppb |
| PCBs | 8082 | 3550 | < 0.05 ppb |
| Oil & Grease | 413.2 | | < 500 ppb |
| Chemical Oxygen Demand | 410.4 | | < 8 ppm |
| Total Cyanide | 335.2 | | < 20 ppb |
| Total Phosphorus | 365.4 | | < 20 ppb |
| Total Kjeldahl Nitrogen | 351.1 | | < 50 ppb |
| Ammonia | 350.1 | | < 50 ppb |
| Nitrate & Nitrite* | 300.0 | | < 50 ppb |

* Holding time is less than 48 hours

All involved agencies must approve these analytical limits.

## Water Quality Monitoring

Water quality monitoring is normally not performed at open water disposal sites under O&M funding authority. Since elutriate tests are conducted prior to dredging and placement operations, only those sediments that pass the elutriate test are allowed to be placed at the open water disposal site without restrictions. Therefore the need for monitoring water quality is not required. Any water quality monitoring at the open water disposal site is beyond the O&M funding authority, and requires other funding sources.

Concerns about water quality at the open water disposal site will be addressed as follows. Two disposal events could be monitored for water quality. The disposal operations are to take place at the center of a 2000 foot square as shown in Figure 8. The corners and center will be marked. The two disposal events will consist of sediment from the LM-5 and LM-8 areas, respectively. The site location and sampling locations are shown in Figures 7 & 8. Water samples will be taken at the depths of 1, 10, and 20 feet below the water surface. Initially before disposal, water samples will be taken at the center of the square. At times of 0.5, 1, 1.5, and 2 hours after disposal, samples will be taken at the corners of the squares. Also at about time 2 hours, samples will be taken at the center of the square. Water sampling will be conducted in such a manner to be consistent with the GLTEM, 1997. Velocity measurements should be collected when water samples are taken. Samples taken for analyses will be filtered through a 0.45 micron filter and analyzed for the following dissolved parameters. The results will be compared to the newest Ohio Water Quality Standards.

| Parameter | Analytical Method | Preparative Method | Detection Limit |
|---|---|---|---|
| Metals | 6010/7000 | 3010A/3020A | < 1 ppb |
| PAHs | 8310 | 3550 | < 2 ppb |
| Pesticides & PCBs | 8081A | 3550 | < 0.1 ppb |
| PCBs | 8082 | 3550 | < 0.05 ppb |
| Oil & Grease | 413.2 | | < 500 ppb |
| Chemical Oxygen Demand | 410.4 | | < 8 ppm |
| Total Cyanide | 335.2 | | < 20 ppb |
| Total Phosphorus | 365.4 | | < 20 ppb |
| Total Kjeldahl Nitrogen | 351.1 | | < 500 ppb |
| Ammonia | 350.1 | | < 50 ppb |
| Nitrate & Nitrite anions* | 300.0 | | < 50 ppb |
| pH | Minimum resolution | | <0.01 pH unit |
| Dissolved Oxygen | Water quality meter | | |
| Conductivity | | | |

* Holding time is less than 48 hours

## Other Requested Testing

### Benthic Diversity

The assessment of benthic diversity is not authorized under O&M funding. However, benthic assessment can be conducted under other funding such as LTMS, etc. The benthic survey will be conducted at the time the sediments are sampled before maintenance dredging, for each of the three open-lake reference sediment samples and the three disposal sediment samples shown in Figure 3. The benthic organism survey should be performed on each of these samples and will include identification and counting of the benthic organisms. A proposal by Dr. Ken Krieger is attached in Appendix B. The proposed work should be conducted for one year and the data evaluated to determine if further work should be conducted in future years.

### Fish Studies

Because of the seasonal and migratory behavior of fish from one day to the next which depends on water temperatures, wind direction and intensity, and food availability, fish studies are deemed not to provide any meaningful information. Such information would be more sensitive to the above parameters than sediment disposal operations. Any fish studies are beyond the funding authority of the O&M program and would require other funding sources. A proposal by Ohio Sate University is attached in Appendix C. This proposal is premature and should be considered after the bioaccumulation bioassay tests are completed and the test data are evaluated. The proposed bioassay tests in the Bioaccumulation Bioassay section of this study plan use the organisms recommended in the GLTEM, 1997 and should give an indication of potential bioaccumulation impacts. If a decision can not be made based on that tests data, perhaps additional testing as proposed in the Ohio State University proposal could be considered. Until that time the proposal should not be funded.

### Algal Studies

There was interest and concern related to the effects of dredged material placement at the open water site on algae. Any studies on algae is beyond the funding authority of the O&M program and will require other funding sources. The impact of algal blooms and diversities is highly dependent on temperatures, winds, and nutrients. It would difficult to get meaningful, dependable, and representative information for the background basis of comparison and for such a small site such as the disposal area. Again, such information may be influenced more by natural conditions than disposal activities. Well-established interpretation techniques would be needed to provide good representative data.

## Sample Handling and Shipping

See attachments.

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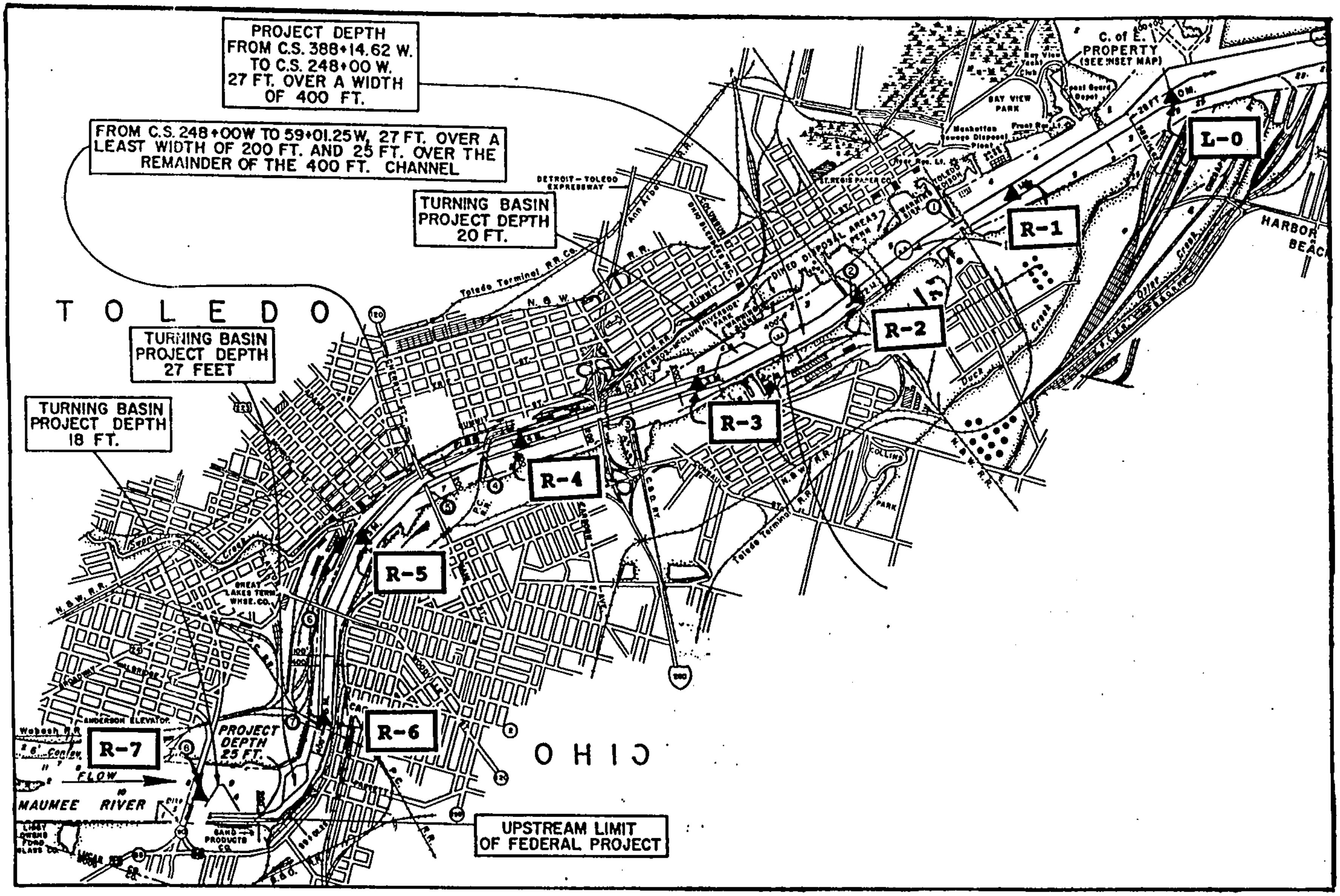



Figure 1 - Toledo Harbor - Maumee River - Sampling Sites.

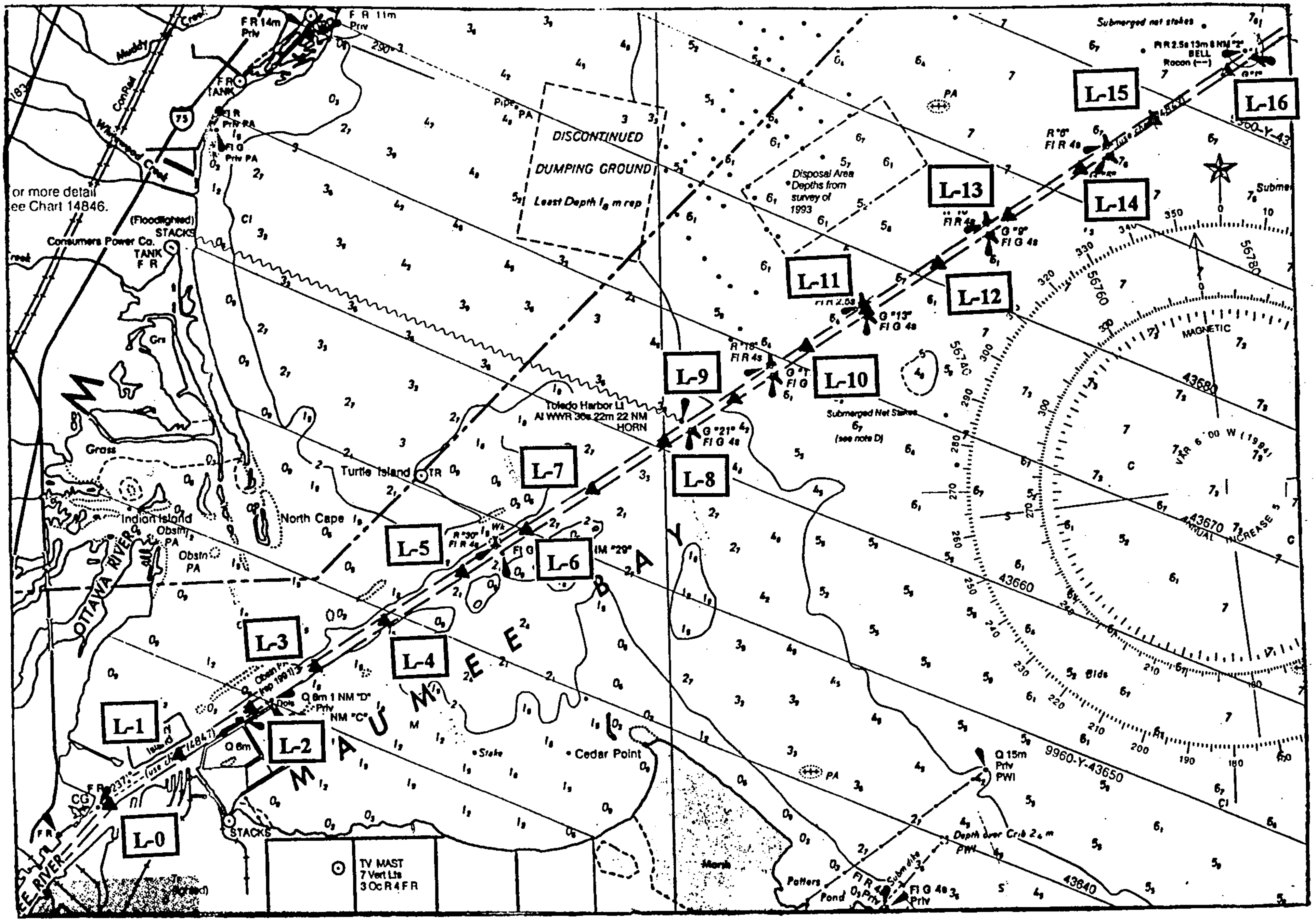



Figure 2 - Toledo Harbor - Lake Channel Sampling Sites.

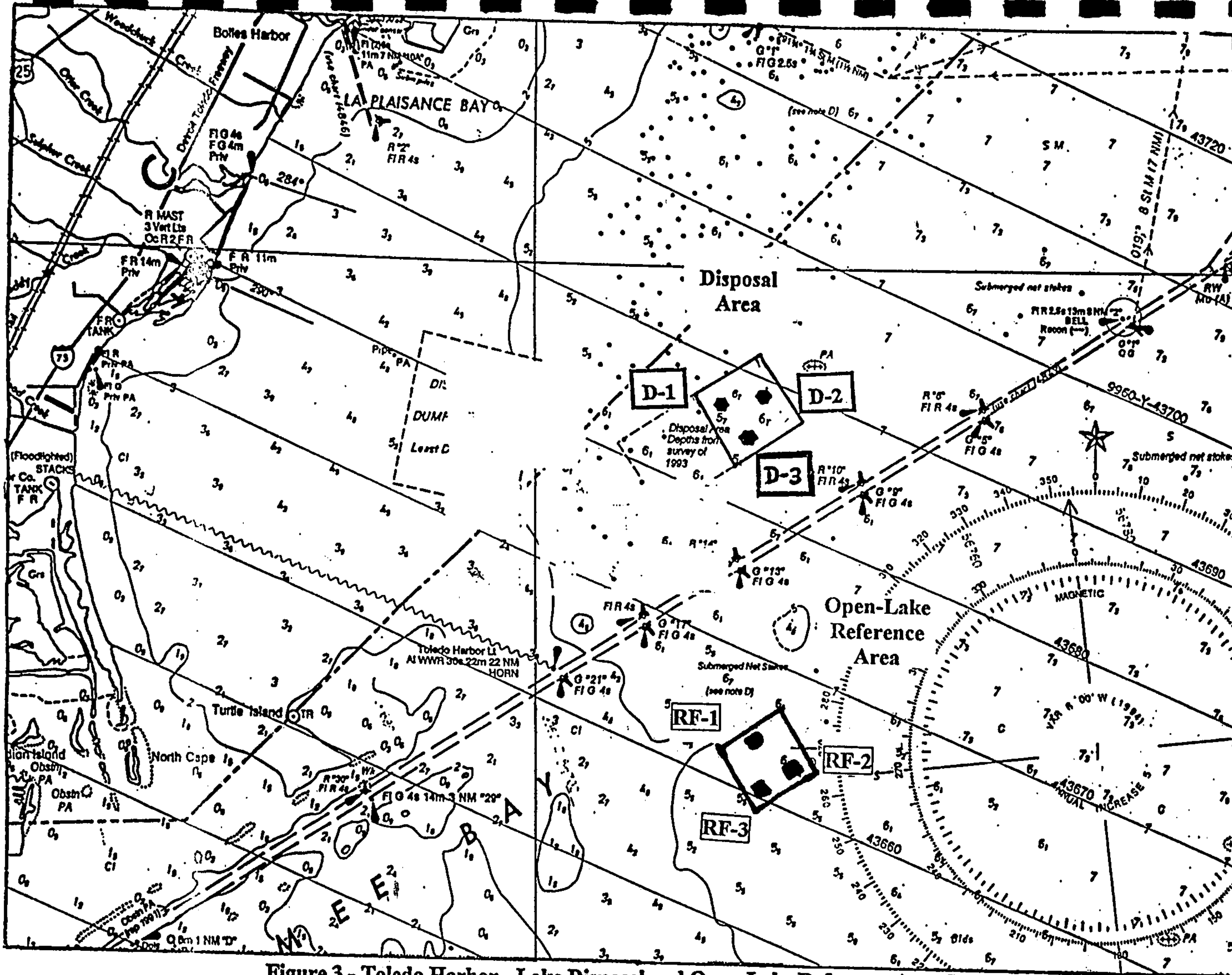



Figure 3 - Toledo Harbor - Lake Disposal and Open-Lake Reference Area Sampling Sites.

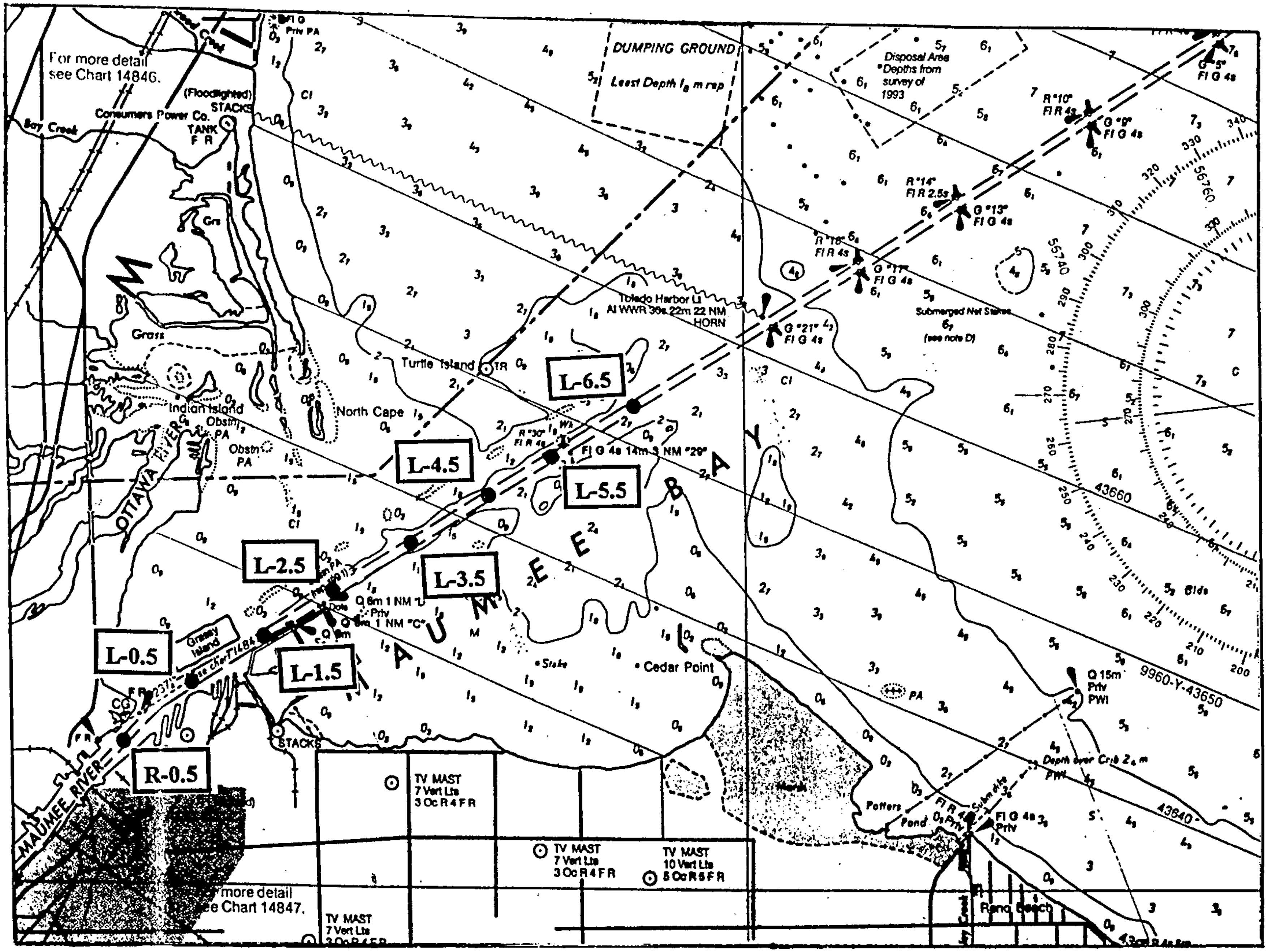



Figure 4 - Toledo Harbor - Lake Entrance Channel Sampling Sites.

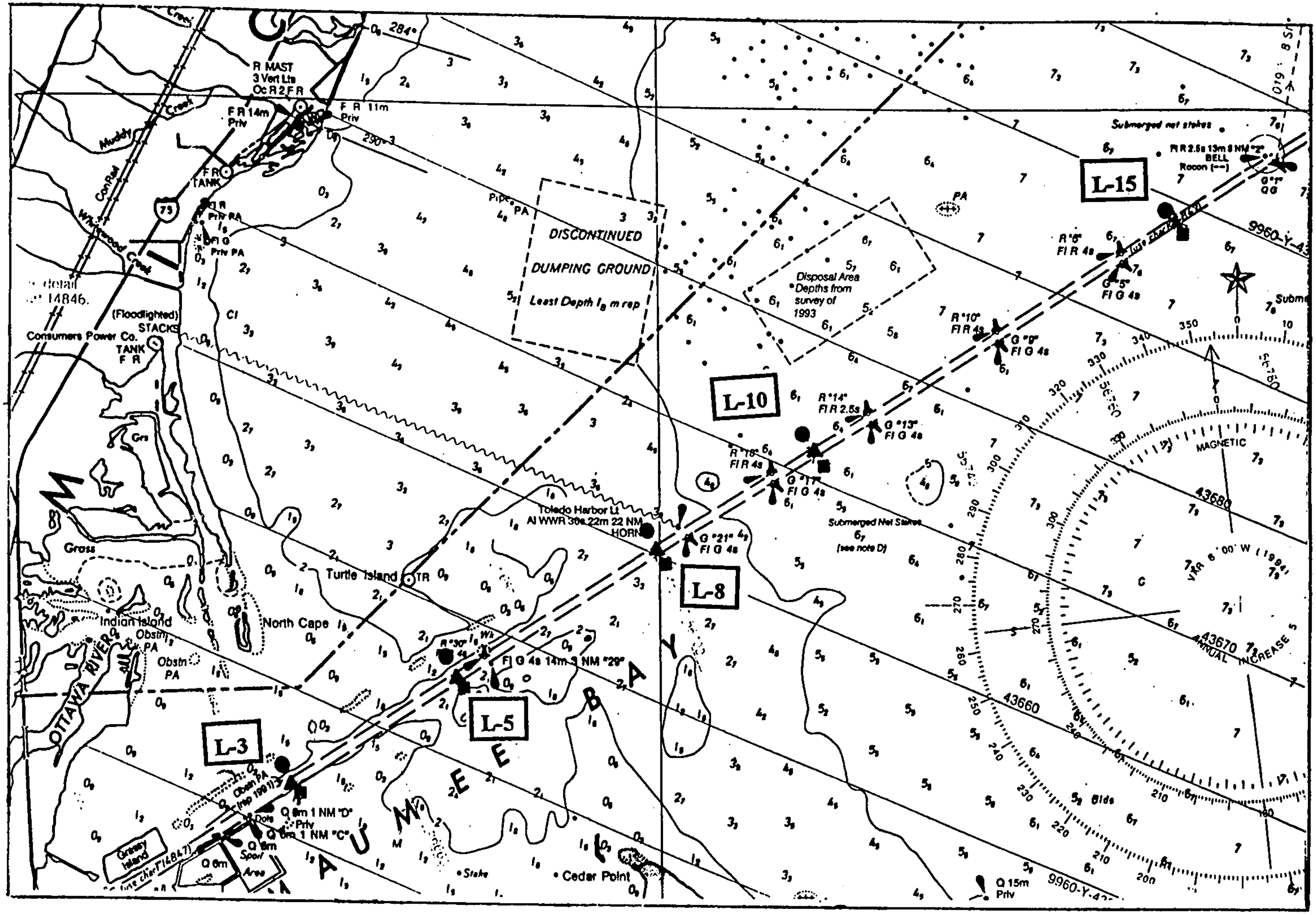



Figure 5 - Toledo Harbor - Lake Channel Side Sampling Sites.

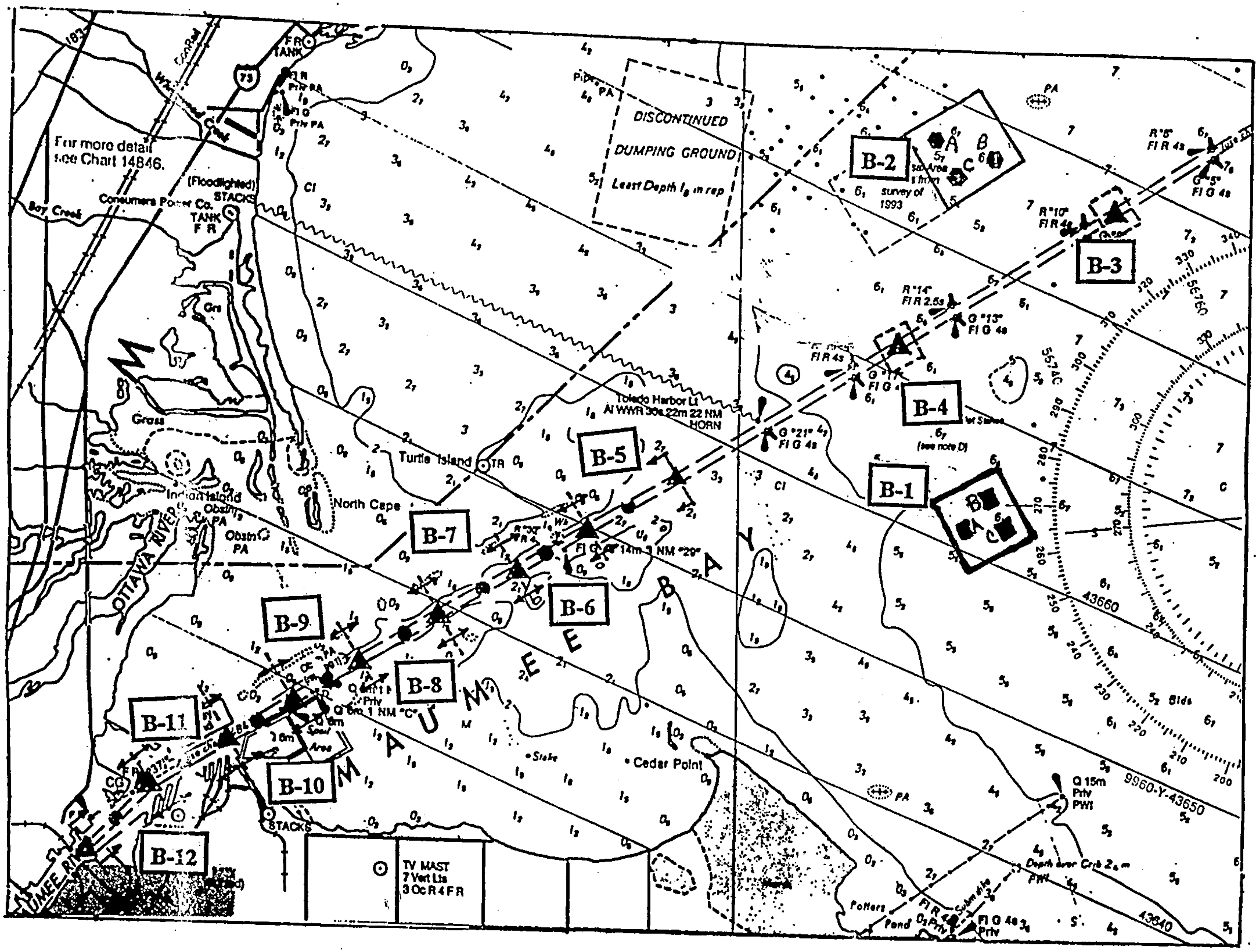



Figure 6 - Toledo Harbor - Biological Testing Areas.

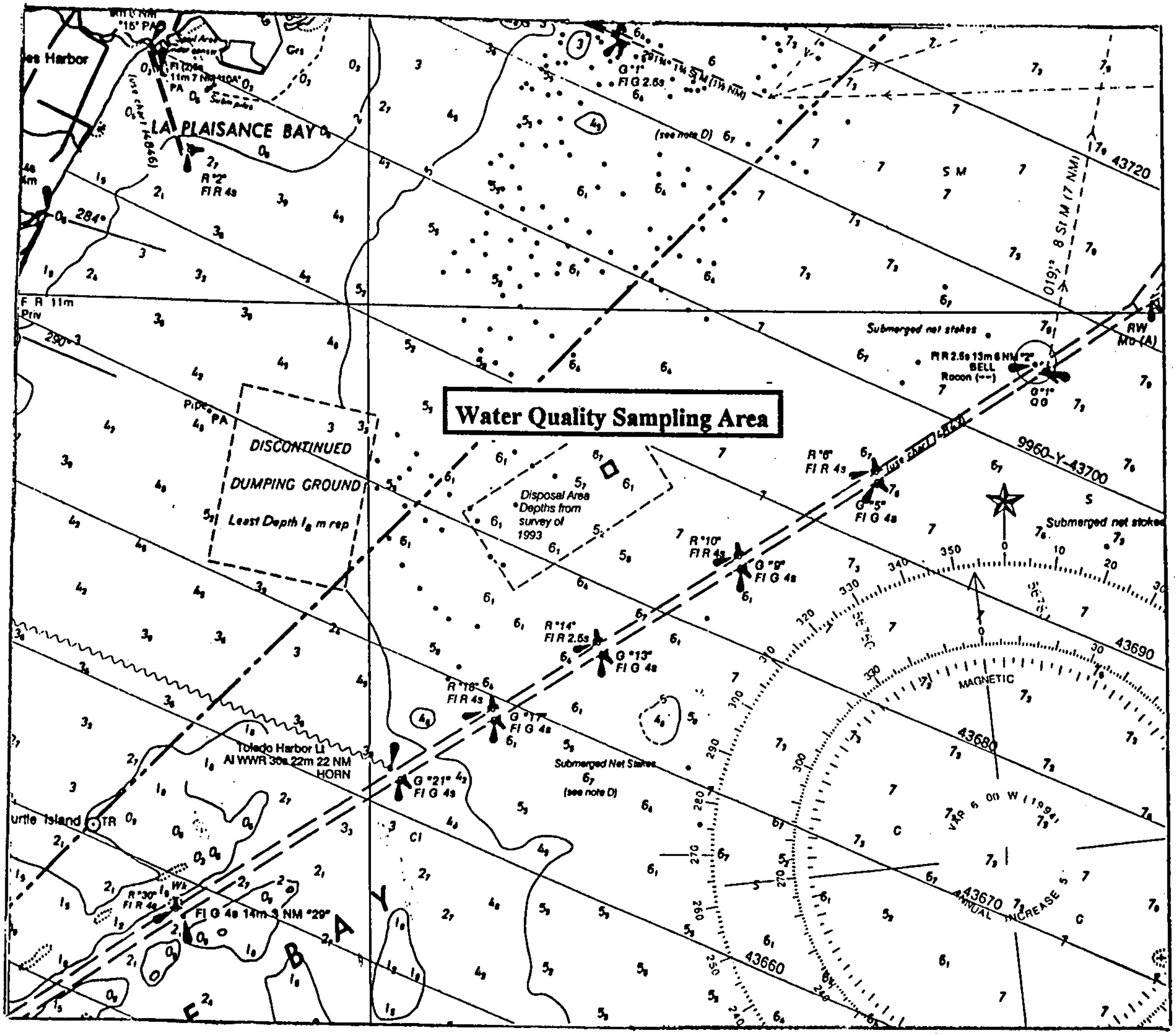



Figure 7 - Toledo Harbor Water Quality Sampling Area.

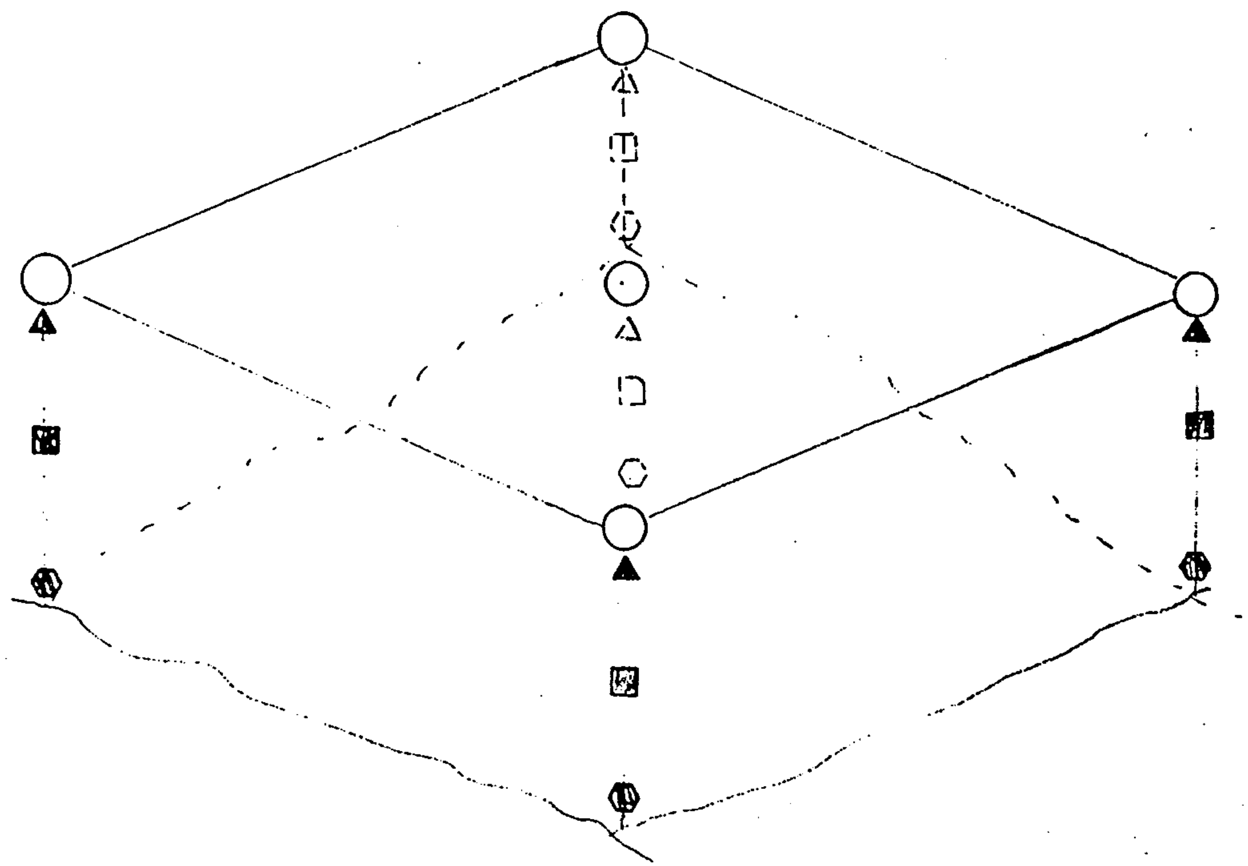


Figure 8 - Toledo Harbor Water Quality Sampling Sites.

# APPENDIX A

## RESPONSE TO CONCERNS

## Response to Concerns:

**What is the distribution of contaminants in the sediments to be dredged (consider both surficial and subsurficial deposits.**

The distribution of contaminants in sediments that are dredged annually usually do not show measurable differences in concentration with sediment depth unless a point source discharge or spill occurred during the year following the previous dredging. Differences in contaminant concentrations are more likely to be measured in channels that have not been dredged for long periods of time, such as 10 or more years. In this case, layers of different contaminant concentrations may be easily measured. This is not the case in Toledo Harbor that requires dredging each year.

Three types of dredges could be used in Toledo Harbor, hydraulic pipeline, mechanical clamshell or dustpan dredge. Usually the sediment is removed to the depth of dredging as much as possible. Consequently, the dredging process removes the entire depth of sediment to be dredged. Hydraulic dredging thoroughly mixes the sediment as it passes through the dredging discharge pipe as and is placed in a confined disposal facility or a barge for transport to the open water placement site. Clamshell dredging places the entire depth of sediment to be dredged in a barge for transport to the placement site. The sediment in the barge is usually slurried with water prior to placement in the CDF. At the open water site sediment from the clamshell operation can also be slurried prior to placement or in some cases can be placed without being slurried. The contractor's equipment will determine what method is used. Whatever equipment is used, any small differences that might have occurred in contaminant concentrations with sediment depth will disappear during the dredging process.

Concern for the potential exposure of contamination after dredging from the sediment remaining in the channel could be warranted if the channel was dredged to a deeper depth than in the past. The current dredging would remove only the upper layers of sediment and not the lower layers of sediment. This situation commonly occurs when a channel has not been dredged for a long period of time or a naturally deep channel had silted in over the years and now the upper portion of the sediment will be removed, exposing lower layers of sediment. These lower layers of sediment may have received a different input of contaminants than the upper layers, depending on the activities occurring in the watershed. For example, there is a project scheduled for dredging after 20 years of silting in. Twenty years ago a creosol facility was operated adjacent to the waterway. Creosol found its way into the waterway and into the sediments at the bottom of the waterway. The facility was closed and over time cleaner sediment covered the creosol sediment in the waterway. The depth of dredging was planned to remove the clean upper sediment and expose the creosol laden lower sediments. Under these conditions, the effects of exposing the more contaminated sediments required evaluation. This should not be the case in Toledo Harbor. It is presumed that shortly after dredging, new sediment will begin to cover the sediment remaining in the channel and the new sediment will be the target of the next year's dredging. Exposure to lower sediments should be short-lived and very temporary. The presence of contaminants in remaining sediments is not an issue that requires evaluation under the O&M program. Such sampling and analysis would require other funding sources.

**Are there toxic levels (chronic or acute) of contaminants in any of these sediments (this will require sediment bioassay)?**

This is addressed in the proposed biological testing section.

**What is the potential for bioaccumulation (or biomagnification) associated with the sediments to be dredged from Toledo Harbor area, regardless of whether they are intended for Confined Disposal Facilities (CDFs) or open lake disposal (OLD).**

The potential for bioaccumulation (or biomagnification) can be determined through bioassay testing. Aquatic bioassays will be conducted to address this for the open water site. There are plant and earthworm bioassays that can be conducted to determine the potential for bioaccumulation at CDFs. However, one needs to consider when plants and earthworms will establish on the CDF. If the dredged material remains under water in the CDF for the first few years of dredging before emerging out of the water so plants can become established, no plants or earthworms will exist on the CDF during this period. There should not be a concern for bioaccumulation in something that does exist on the site. Later evaluations of dredged material to be dredged and placed above the water should consider conducting these tests if there is reason to believe bioaccumulation might occur. Plant bioassays have been conducted for Cell 1 dredged material and no significant bioaccumulation was observed. Manufactured soil testing and demonstration has also shown no significant bioaccumulation will occur from the dredged material from Cell 1. Unless the quality of the sediment in Toledo Harbor has changed from the past five years, no significant plant or earthworm bioaccumulation of contaminants should occur.

**Are adequate reference sites available for sediment conditions for the purposes of this project? It seems likely that such sites are available, through OEPA, Environment Canada, etc.**

Reference sites for test comparisons are usually located in the environs of the disposal site. The Clean Water Act specifies the evaluation of adverse impacts to the disposal site environs. Therefore, reference sites near the disposal site and whose sediments are of similar physical characteristics as the dredged material should be selected for test comparisons.

**What is the existing condition of sediments in the area planned for OLD? Will this require the collection of data on surficial and subsurficial sediment conditions throughout the proposed disposal area. Toxicity and bioaccumulation – potential data will be required from this area. Toxicity testing by means of bioassays and bioaccumulation screening will be required to answer these questions.**

Existing conditions at the open lake disposal site are usually monitored physically to determine if the mound created from previous placement operations is present. Normally, the chemical and biological conditions are not monitored. The dredged material placed at the open lake disposal site has passed prior laboratory bioassay tests and therefore should not cause adverse impacts at the site other then burying what is there. If what is there is buried, the sediment conditions prior to placement will not be exposed to the surface of the mound, therefore this should not be of a concern. This type of monitoring is beyond that required by the regulations and normally is beyond the funding authority of the Corps District's O&M program. Other funding sources are required to accomplish this monitoring data.

**This study should address the following concern: Since CDFs, as constructed, are not true containment vessels (i.e. they allow leaching of sediment constituents), are they a source of contamination to surrounding water and proximate sediments?**

This question is usually addressed by conducting leaching tests according to the USACE/EPA Technical Framework (USACE/EPA, 1992). The tests are conducted on aerobic and anaerobic dredged material that will be dredged and placed in the CDF. Test results indicate the potential for leaching of contaminants. If there is a potential for leaching, then restrictions can be applied to manage the leaching (liners, slurry walls, etc.) If the sediment in Toledo Harbor has not changed over the past five years, the levels of contaminants were relatively low and the sediment was very fine textured. Therefore, leaching of contaminants should be relatively low. For the new cell at Toledo, it is my understanding that a clay core was placed in the constructed dike and three groundwater wells were placed below this dike. An alternative method to verify that no leaching occurs would be to monitor the groundwater in these wells. This monitoring is beyond the funding authority of the O&M program. Other funding sources are required to accomplish this monitoring.

**What is the historical evidence in the disposal area, which is associated with past disposal practices (i.e. what will core sections indicate vis a vis past disposal practices – e.g. are there definable layers of disposal materials interspersed with natural deposition and what does this evidence, or lack of it, mean for the area?) It may be advisable to conduct sediment sampling and analysis on a transect which passes through the proposed disposal area and extends across a relatively significant area of the western end of Lake Erie, to supply evidence regarding long-term changes in the area (transect approach is only one of several potential study methods and may not be the most appropriate – this will need to be determined by the study team).**

This evaluation is normally beyond the authorized funding of the Corps District's O&M program. Sediment samples could be included in the testing as the disposal site reference. Sediment samples from the navigation channel that show no statistical difference from the disposal site reference sediment samples in the biological tests will mean those sediments can be placed at the OLD without adverse impacts.

**What is the population structure, distribution, taxonomy of the benthic macroorganisms in the disposal area and surrounding areas (reference sites will be required for this inquiry)**

This question is interesting for the purpose of documenting what might be at the disposal site, but is not normally determined at aquatic disposal sites and is beyond the authorized funding for the Corps District's O&M program. Other funding sources are required to accomplish this evaluation.

**What is the population structure, distribution, taxonomy of the benthic plant community in the disposal area and surrounding areas (reference information required)?**

This question is interesting for the purpose of documenting what might be at the disposal site, but is not normally determined at aquatic disposal sites and is beyond the authorized funding for the Corps District's O&M program. Other funding sources are required to accomplish this evaluation.

**We need to know more about redistribution of disposed sediments in the proposed area; what really happens to these materials following contact with the receiving water? Do these disposed materials actually stay in the disposal area or can they be relocated by physical actions to other areas of the lake?**

This question is being addressed by Ohio State University. Reports will be available in March 1999.

**What are the effects of disposed materials on the water column – (this must account for Water Quality Standards issues, bioaccumulation issues, direct physical effects, as well)?**

Elutriate testing addresses this question. The test was developed to determine the potential for release of contaminants into the water column during open water disposal operations. The elutriate can be analyzed chemically and compared to appropriate water quality standards. The elutriate can also be tested with water column bioassays. These tests are described in the Corps/EPA Technical Framework and the Inland Test Manual. Because water column effects are temporary, acute toxicity testing is conducted rather than bioaccumulation testing. Bioaccumulation tests are usually conducted on benthic organisms in solid sediment tests for a longer period of exposure such as 28 days.

**What are the effects of disposed materials on the existing benthic habitat and community (plants, benthic macroinvertebrates, fish)?**

Normally it is accepted that disposed materials will cover the entire benthic community and habitat. Usually recolonization of aquatic disposal sites is relatively rapid. This evaluation is beyond the funding authority of the Corps District's O&M program. Other funding soures are required to accomplish this.

**What potential effects need be considered vis a vis the Toledo water supply intake?**

This question is being addressed by Ohio State University and will be discussed in the final report.

**How will this study address both the short term and long term effects of disposal on the water column, benthic community?**

Short term effects on the water column are evaluated with the elutriate test. There are no long term effects on the water column. Temporary short-term effects are produced, not long-term water column effects. Both short and long-term effects are possible for benthic organisms. Consequently, benthic bioassays can be conducted to determine potential effects. Acute toxicity and chronic toxicity tests can be conducted according to the Corps/EPA Technical Framework and the Inland Testing Manual.

**Is it possible to use data derived from this study to determine the potential for the use of selected indicator organisms, parameters, etc. to track the long term effects of open lake disposal?**

This may be extremely difficult since the lake is an active environment and the disposal site is effected by lake effects and other sources of sediment. Effects at the disposal site will be confounded by other factors and will not be indicative of disposed material.

**How will comparative risk be evaluated, considering the possible pathways for bioaccumulation and toxicity in benthos, fish, waterfowl, eagles, human beings?**

Normally each potential pathway is evaluated. The potential risk for adverse impacts is evaluated and documented. Any and all risks are considered for acceptability. If the risks are not acceptable, restrictions and controls are identified that will allow the management of risk to an acceptable level. For example, should a sediment sample show unacceptable aquatic toxicity or bioaccumulation, that sediment location should not be placed at the open water site, but rather be placed in the CDF to manage the risk to the aquatic environment.

**Will open lake disposal of dredged sediments from the Toledo Harbor be a source of increased phosphorus concentrations in the western end of Lake Erie?**

The sediment dredged from the Toledo Harbor is sediment on its way to Lake Erie. Depending on the storm flow through the channel, the upper layers of sediment will eventually end up in the lake. Placement of the sediment from the channel at the disposal site may increase the surface area exposed to lake water for potential solubilization of phosphorus. However, the increase most likely can not be measured.

**While this study may not directly related to research concerning the "Zebra Mussel question", it nevertheless must be concerned with the growing indications that these organisms are a source of significant bioaccumulation of chemicals of concern in Lake Erie.**

These organisms usually attach to structures and can filter and clean water they are exposed to. Removal of these organisms and disposition could be a source of chemicals of concern. The use of Zebra Mussels for monitoring has been discussed in the Ohio State University proposal. The conduct of this research should be considered after the initial testing is completed and the results are evaluated.

**An adequate and acceptable list of chemical parameters for analysis must be maintained by the study plan under consideration.**

The list of chemicals of concern in this study plan is based on a comprehensive review of all available information and has been agreed upon through consensus.

**State of Ohio Water Quality Standards issues, mixing zones must be addressed.**

All tests that determine impacts on water quality will be evaluated in relation to the latest State Standards. Open water placement evaluations under the Clean Water Act, Section 404, normally consider mixing zones.

**Regarding the use of sediment bioassay tests, addressed in several points in this document, the organisms to be used for such tests must be agreed upon by all parties prior to study plan finalization; i.e. number of taxa to be used and types of tests to be conducted.**

All parties prior to the study plan finalization will agree upon the entire study plan. The organisms should be consistent with the Regional Testing Manual.

**How would you track long term effects? What would you use as a baseline?**

If only sediment that shows no adverse impacts in comprehensive biological testing are placed at the OLD, there shouldn't be long term effects. The proposed research by Dr. Ken Krieger would track effects over time if conducted each year at the open lake disposal site. The Reference site recommended in this study plan could be used as comparison.

# APPENDIX B

**PROPOSAL**

**Kenneth A. Krieger, Ph.D.**

**Heidelberg College Water Quality Laboratory**

## Proposal

Heidelberg College Water Quality Laboratory

***Assessment of Macroinvertebrate Community In and Around an Open-Lake Disposal Area, Western Basin of Lake Erie***

Kenneth A. Krieger, Ph.D., Principal Investigator

**Objective:** To determine whether the open-lake disposal of dredge spoils from the nearby Maumee Bay shipping channel has an impact on the benthic macroinvertebrate community at the disposal site, as measured by sampling prior to disposal and the next year following disposal.

**Experimental Design:** See attached drawing of disposal site and suggested distribution of stations. This is subject to discussion and modification. We propose 22 sites and will collect three replicate samples at each site each year (pre and post disposal).

Total number of samples:
66 per year, 132 for entire study. Site distribution:

5 sites within the disposal area.

8 sites in an inner ring just outside the designated disposal area.

8 sites in an outer ring approximately 1 to 1.5 miles beyond the inner ring of sites; this group includes one southwestern site that lies within the disposal area.

1 site to the southwest as an extension of the outer ring that would be used for comparison with the site lying within the disposal area.

**Methods:** We will quantitatively sample the benthic macroinvertebrates with a large Ekman dredge, which has been successfully used for years in the sediments of the western basin. If one of our sites cannot be sampled successfully with the Ekman, we will shift the site location slightly to find sediment similar to that at the other sites; we will have a Ponar sampler on hand to attempt to collect the samples if necessary. Sample collections will probably require two to three full days each year. We will conduct the sampling from a 25-ft. Proline operated by the Lake Erie Center of the University of Toledo at Maumee Bay State Park.

Each sample will be rinsed on board through a standard No. 30 (0.60 mm) mesh screen. Sample residues will be preserved with formaldehyde and will be returned to the Water Quality Laboratory at Heidelberg College. There the macroinvertebrates will be picked and sorted from the samples and will be stored in ethanol pending identification and counting. All animals will be identified to the lowest taxon practical. Subsampling of some taxa, if required, will follow standard procedures. All taxa will be reported as the number of individuals per square meter of lake bottom.

**Statistical Analyses:** The experimental design will permit the following analyses:

a. Analysis of variance, comparing the outer ring, inner ring, and disposal site groups of stations.

b. Pairwise similarity indices, such as Jaccard's Index and Bray-Curtis Index.

c. Cluster analysis, which will demonstrate the grouping of stations according to their overall taxonomic similarities (species composition as well as abundance of each taxon).

d. Correlation analysis between macroinvertebrate taxa and sediment chemical variables, if the latter data are generated by another investigator and are made available.

**Products:** We will produce an interim report in December 1999 (unless requested earlier), and a final report by December 2000. The final report will present a detailed set of data as well as the findings and conclusions of the study.

**Budget:** The budget includes salary for the principal investigator (Krieger) and for one student, who will be employed full time during each summer of the study. Fringe benefits are charged only for the P.I. We show as subcontracted services the use of the Lake Erie Center boat ($100/day) and an estimate of the boat pilot's time ($50/hour). Indirect costs are charged at the current rate approved for Heidelberg College by the U.S. Dept. of Health and Human Services on the basis of 65.0% of salaries, wages and fringe benefits. Given the short notice for developing the project proposal, we expect that some adjustment to the budget may be necessary.

Please contact Ken Krieger at Heidelberg College with questions about the proposal and budget:

Phone: 419 448-2226
Fax: 419 448-2124
e-mail: kkrieger@mail.heidelberg.edu

Submitted 25 February 1999

Kenneth A. Krieger, Ph.D.
Senior Research Scientist
Heidelberg College

| | A | B | C |
|---|---|---|---|
| 1 | BUDGET FOR MACROINVERTEBRATE ASSESSMENT | | |
| 2 | | | |
| 3 | | | YEAR 1, 1999 |
| 4 | 1. PERSONNEL | | |
| 5 | | SALARIES & WAGES | |
| 6 | | a. P.I. (Krieger) | 9144.32 |
| 7 | | b. Student Tech. | 3200.00 |
| 8 | | BENEFITS @ 0.22 P.I. Sal. | 2011.75 |
| 9 | | TOTAL PERSONNEL | 14356.07 |
| 10 | | | |
| 11 | 2. SUPPLIES | | |
| 12 | | a. Sample jars, vials, ethanol, etc. | 300.00 |
| 13 | | b. Statistical software | 500.00 |
| 14 | | c. Miscel. supplies, parts | 150.00 |
| 15 | | TOTAL SUPPLIES | 950.00 |
| 16 | 3. EQUIPMENT | | |
| 17 | | a. Ekman dredge | 600.00 |
| 18 | | b. Electric winch | 800.00 |
| 19 | | TOTAL EQUIPMENT | 1400.00 |
| 20 | | | |
| 21 | 4. TRAVEL | | |
| 22 | | 7 round-trips to boat/YR | 237.44 |
| 23 | | 2 annual meetings/conferences | 600.00 |
| 24 | | TOTAL TRAVEL | 837.44 |
| 25 | 5. OTHER | | |
| 26 | | a. Use of computers | 300.00 |
| 27 | | b. | |
| 28 | | TOTAL OTHER | 300.00 |
| 29 | | | |
| 30 | 6. SUBCONTRACTED SERVICES | | |
| 31 | | a. Use of L. Erie Center boat, 3 d/y | 300.00 |
| 32 | | b. Boat pilot, 3 d/y | 1500.00 |
| 33 | | TOTAL SUBCONTRACTED | 1800.00 |
| 34 | | | |
| 35 | TOTAL DIRECT COSTS (1-6) | | 19643.51 |
| 36 | INDIRECT COSTS (@65.0% total pers.) | | 9331.45 |
| 37 | TOTAL PROJECT COSTS | | 28974.96 |

| | D | E | F |
|---|---|---|---|
| 1 | | | |
| 2 | | | |
| 3 | YEAR 2, 2000 | TOTAL | |
| 4 | | | |
| 5 | | | |
| 6 | 10010.80 | 19155.12 | |
| 7 | 3328.00 | 6528.00 | |
| 8 | 2202.38 | 4214.13 | |
| 9 | 15541.18 | 29897.25 | |
| 10 | | | |
| 11 | | | |
| 12 | 300.00 | 600.00 | |
| 13 | 0 | 500.00 | |
| 14 | 150.00 | 300.00 | |
| 15 | 450.00 | 1400.00 | |
| 16 | | | |
| 17 | 0 | 600.00 | |
| 18 | 0 | 800.00 | |
| 19 | 0 | 1400.00 | |
| 20 | | | |
| 21 | | | |
| 22 | 237.44 | 474.88 | |
| 23 | 600.00 | 1200.00 | |
| 24 | 837.44 | 1674.88 | |
| 25 | | | |
| 26 | 300.00 | 600.00 | |
| 27 | | 0 | |
| 28 | 300.00 | 600.00 | |
| 29 | | | |
| 30 | | | |
| 31 | 300.00 | 600.00 | 3 d x $60/h x 10-h days |
| 32 | 1500.00 | 3000.00 | |
| 33 | 1800.00 | 3600.00 | |
| 34 | | | |
| 35 | 18928.62 | 38572.13 | |
| 36 | 10101.76 | 19433.21 | |
| 37 | 29030.38 | 58005.34 | |

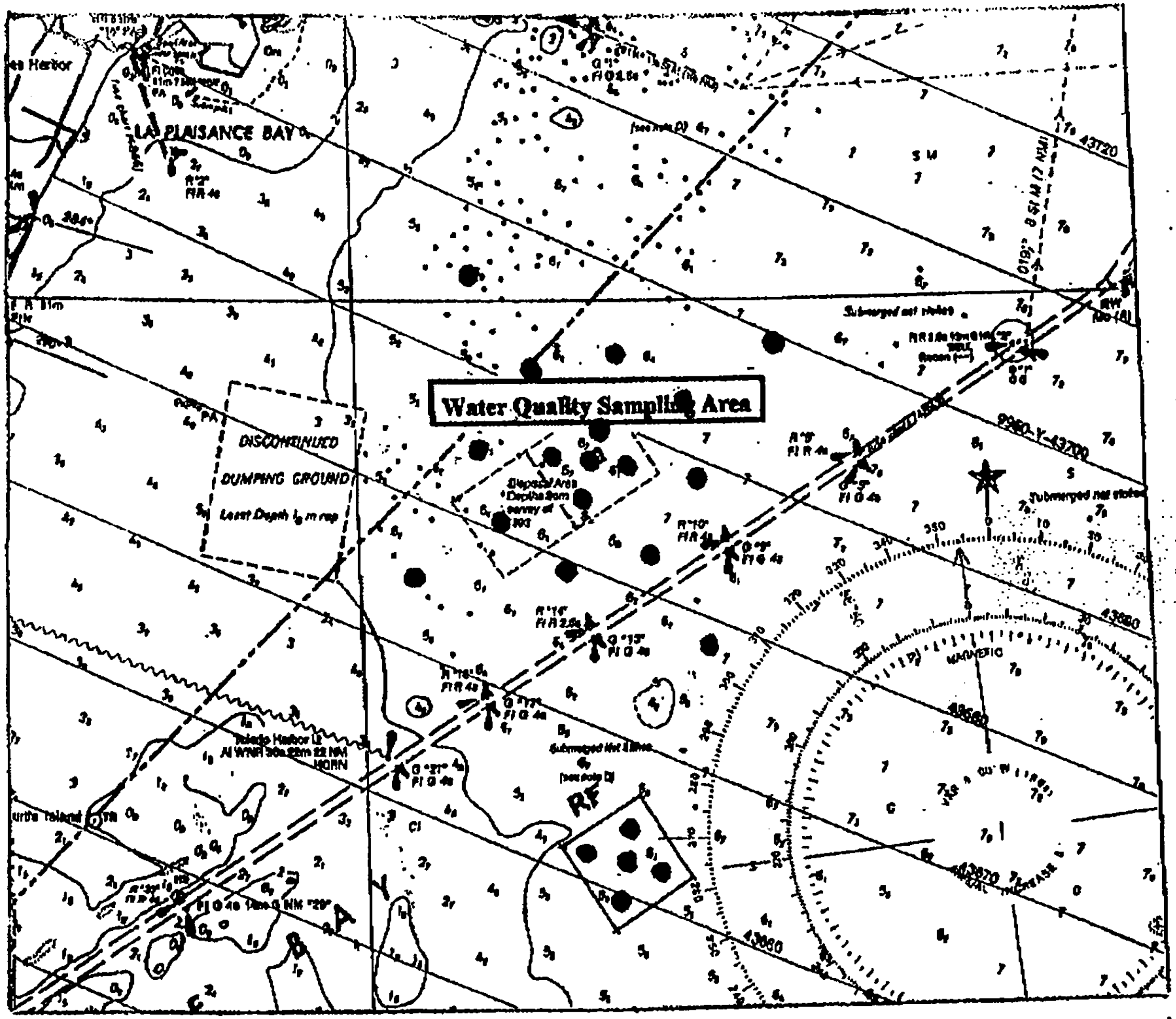



Figure 7 - Toledo Harbor Water Quality Sampling Area.

● Macroinvertebrate Sampling Site N = 22

# APPENDIX C

## PROPOSAL

**Ohio State University**

**R. A. Stein, E. A. Marschall, S. W. Fisher, and G. W. Kim**

**Description of the Proposed Work - Problem Statement:**
Depositing contaminated sediments into open-lake sites can be deleterious to the environment if physico-chemical or ecological processes make contaminants bioavailable. An evaluation in 1987 concluded that dredged sediments from the Lake Erie portion of the Toledo Harbor navigation channel were suitable for open-lake disposal (Hoke et al. 1990; J. Great Lakes Res. 16:457-470). However, biota of the western basin of Lake Erie (WBLE) has changed greatly over the past decade, likely affecting contaminant bioavailability and necessitating a re-evaluation of this disposal practice.

The biota of WBLE has changed greatly through colonization of exotic species and dramatic recovery of nearly extirpated species. These include zebra mussels (*Dreissena polymorpha*; since 1988), round gobies (*Neogobius melanostomus*; since 1993), and burrowing mayflies (*Hexagenia* spp.; recolonizing since the early 1990s). By ingesting contaminated algae and suspended sediments, zebra mussels can be efficient contaminant-transfer pathways to the rest of the food web. Transfer and biomagnification to the rest of the food web can occur when zebra mussels are consumed by round gobies or zebra mussel feces are consumed by a benthic amphipod *Gammarus fasciatus*. The link to sport fish has been supported by recent recovery of high numbers of these prey from walleye (*Stizostedion vitreum*), smallmouth bass (*Micropterus dolomieu*), and yellow perch (*Perca flavescens*) stomachs.

Sport-fish food webs in WBLE have changed dramatically due to improvements in agricultural and industrial practices, and phosphorus abatement. Since the early 1970s, water clarity has increased and productivity has decreased. In response, the sport-fish food web has shifted from a prey base dominated by pollution-tolerant, soft-rayed, planktivorous prey fishes to one dominated by pollution-intolerant, spiny-rayed, benthivorous prey fishes. These changes likely affect contaminant bioavailability and threaten valuable sport fisheries.

Given these dramatic changes in contaminant-transfer pathways and sport-fish food webs, a re-evaluation of bioaccumulation of contaminants from dredged sediments is necessary. Connecting, predicting, and managing interactions between contaminants and aquatic food webs is difficult and requires basic information on changes in bioavailability, bioaccumulation, physiology, and life history of individuals and an understanding of how these affect the population and community levels.

**Summary of Project Work Plan:**
We hypothesize that documented changes in the biota in WBLE have changed bioavailability of contaminants in dredged materials. We will assess food-web bioaccumulation from open-lake disposal by: (1) empirically evaluating contaminant bioaccumulation from dredged materials, and (2) combining models with empirical data on food-web dynamics to determine the probability of these effects being realized in valuable sport-fish food webs. By combining these approaches, we can estimate if open-lake disposal of dredged materials will have an impact on food webs (i.e., complex biotic interactions above the level of the individual).

Objective 1: Bioaccumulation of hydrophobic contaminants from dredged sediments in Toledo Harbor
We will use both laboratory and *in situ* assessments of bioaccumulation of contaminants from dredged sediments. We will conduct congener-specific PCB analysis in addition to other parameters selected on the basis of potential for bioaccumulation (log $K_{ow}$) and previous sediment characterizations. The sites we select will be located throughout the dredging area in addition to reference sites. We will also sample open-lake disposal sites to evaluate previously disposed dredging materials.

We will collect and return sediment samples to the laboratory according to USEPA and ASTM protocols. From all sites, we will conduct whole sediment bioaccumulation tests in the laboratory using selected organisms, including round gobies and zebra mussels. From the proposed disposal and reference sites, we will conduct 34-d *in situ* exposure tests, placing zebra mussels in both the sediment and water column (Roper et al. 1996; Environmental Pollution 94:117-129). This combination of laboratory and *in situ* assessments will determine the potential for significant bioaccumulation of contaminants from dredged sediments above levels currently found in Toledo Harbor. Furthermore, bioaccumulation difference due to placement position (water column vs. sediments) will provide insight relative to exposure path.

Objective 2: Food-web uptake of contaminants in Toledo Harbor
We will evaluate the potential for transfer and biomagnification of contaminants into the food web by combining field measurements of the sport-fish food web, experimental evaluation of predation rates, and bioenergetic modeling of physiological parameters in fishes. At the proposed sites, we will sample fish-community composition, density, prey availability, and stomach contents. Additionally, we will measure algal biomass, bottom substrate, water clarity, and water temperature. In the laboratory and in outdoor enclosures, we will conduct feeding-rate experiments on round goby and zebra mussels, fishes and round gobies, and fishes and amphipods to quantify potential contaminant uptake.

Finally, the bioaccumulation and bioenergetic models can be combined to predict contaminant body burden, growth, metabolism, and excretion in fishes (Stow et al. 1995; BioScience 45:752-758). From this, we can evaluate if dredged sediments will significantly increase bioaccumulation risk above current levels, especially in the valuable sport fishery.

**Preliminary project annual budgets for principal investigators (PIs), a research assistant, and a graduate research assistant (GRA), including indirect costs (IDC). Salaries are subject to a 5% annual increase:**

| Category | FY2000 | FY 2001 | FY 2002 | |
|---|---|---|---|---|
| Personnel | | | | |
| GRA (12 mo. @$1210/mo) | 14,520 | 15,246 | 16,008 | |
| Fringes (1.2%) | 174 | 183 | 192 | |
| Res. Asst. Salary (12 mo. @$1950/mo.) | 23,400 | 24,570 | 25,799 | |
| Fringes (25.4%) | 5,944 | 6,241 | 6,553 | |
| RAS Salary (1/2 mo. @ $9995/mo.) | 4,998 | 5,248 | 5,510 | |
| Fringes (23.6%) | 1,180 | 1,239 | 1,300 | |
| EAM Salary (1/2 mo. @$5630/mo.) | 2,815 | 2,956 | 3,104 | |
| Fringes (23.6%) | 664 | 698 | 733 | |
| SWF Salary (1/2 mo. @$4500/mo.) | 2250 | 2363 | 2481 | |
| Fringes (16%) | 360 | 378 | 397 | |
| | *56,305* | *59,122* | *62,077* | *Subtotal* |
| Travel | | | | |
| To Toledo Harbor (10 trips × 250 miles @$0.41) | 1,025 | 1,025 | 1,025 | |
| 2 Overnights @ $100/night | 200 | 200 | 200 | |
| To meetings for 2 persons/year ($750 × 2) | 1,500 | 1,500 | 1,500 | |
| | *2,725* | *2,725* | *2,725* | *Subtotal* |
| *In Situ* Bioaccumulation Study | | | | |
| Equipment maintenance and repair | 1,000 | 1,000 | 1,000 | |
| Congener-Specific PCB (3 dates × 2 sites × 5 reps) | 2,500 | 2,500 | 2,500 | |
| Additional analysis (e.g., dioxins, heavy metals) (Contracted @ 2 dates × 2 sites × 5 reps × $600/sample) | 12,000 | 12,000 | 12,000 | |
| | *15,500* | *15,500* | *15,500* | *Subtotal* |
| Laboratory Bioaccumulation Study | | | | |
| Equipment maintenance and repair | 1,000 | 1,000 | 1,000 | |
| Congener-Specific PCB (3 dates × 3 sites × 5 reps) | 2,500 | 2,500 | 2,500 | |
| Additional analysis (e.g., dioxins, heavy metals) (Contracted @ 2 dates × 3 sites × 5 reps × $600/sample) | 18,000 | 18,000 | 18,000 | |
| | *21,500* | *21,500* | *21,500* | *Subtotal* |
| Food-Web Modeling | | | | |
| Fish sampling equipment and repair | 400 | 400 | 400 | |
| Fish housing/feeding during experiments | 1100 | 1100 | 1100 | |
| Computer | 3,000 | 0 | 0 | |
| Software | 500 | 500 | 500 | |
| | *5,000* | *2,000* | *2,000* | *Subtotal* |
| Total Direct Costs (TDC) | ***101,030*** | ***100,847*** | ***108,302*** | |
| Total Direct Costs Subject to IDC | ***98,030*** | ***100,847*** | ***108,302*** | |
| Total IDC (@46%) | ***45,094*** | ***46,389*** | ***49,819*** | |
| Total Funding Requested per year (TDC + IDC) | ***146,124*** | ***147,237*** | ***158,121*** | ***Grand Total*** |

# ATTACHMENTS

# USEPA SAMPLE CONTAINERS

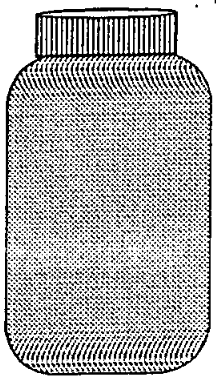
| Container Type | Description | Used for Sample |
|---|---|---|
| A | 80-oz. amber glass bottle with teflon-lined black phenolic cap | Extractable Organics |
| B | 40-ml glass vial with teflon-backed silicon septum cap | Volatile Organics, Aqueous, Non-aqueous |
| C | 1-L high-density polyethylene (HDPE) bottle with poly-lined, baked poly cap | Metals,Cyanide, & Sulfide, Aqueous |
| D | 125-ml / 4-oz. glass vial, tall wide mouth with teflon-backed silicon septum cap | Volatile Organics non-aqueous |
| E | 16-oz. wide mouth glass jar with teflon-lined, black poly cap | Extractable Organics & Metals In Soils & Med/High Water |
| F | 8-oz. wide-mouth glass jar with teflon-lined, black poly cap | (Same as Type E) |
| G | 4-oz. wide-mouth glass jar with teflon-lined, black poly cap | Extractable Organics & Metals and Cyanide, non-aqueous |
| H | 1-L amber glass bottle with teflon-lined, black poly cap | Extractable Organics, Aqueous |
| J | 1-L, wide mouth glass jar with teflon-lined, black poly cap | (Same as Type E) |
| K | 4-L amber glass bottle with teflon-lined, black phenolic cap | (Same as Type A) |
| L | 500-ml high-density polyethylene bottle with poly-lined, baked poly cap | (Same as Type C) |

# INORGANIC SAMPLE CONTAINER AND VOLUME REQUIREMENTS

## Water Analysis

Metals or Cyanide ($CN^-$) analysis

Type C
1 x 1 L polyethylene bottle

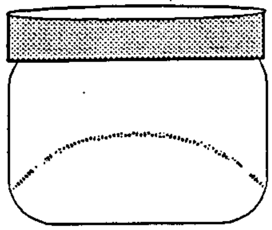


## Soil/Sediment Analysis

Metals or Cyanide ($CN^-$) analysis

Type G

1 x 4 -oz. wide mouth

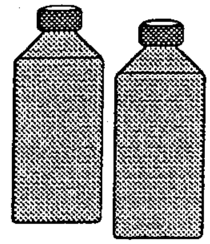


# ORGANIC SAMPLE CONTAINER AND VOLUME REQUIREMENTS

## Water Analysis

SVOA's or Pest/PCBs

Type H
1 x 1L Amber glass bottles



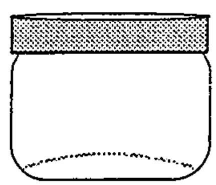
VOA

Type B
3 x 40-ml glass vials with septa top

## Soil/Sediment Analysis

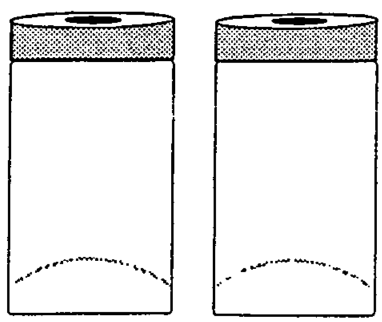
SVOA's or Pest/PCBs

Type G
1 x 4 -oz. wide mouth



VOA

Type D
2x125-ml/4-oz.wide mouth with septa top



# Buffalo District

## Sample Packaging Procedures

1. Pack properly sealed, labeled (clear tape over label), foam wrapped, and tagged sample in heavy duty Zip-lock plastic bag.

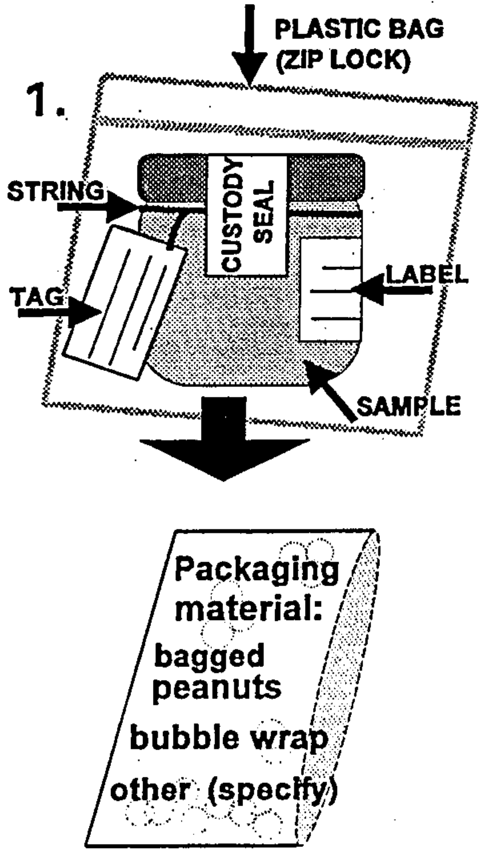
2. Pack Zip-lock plastic bag in shipment cooler. Do not use factory container boxes, vermiculite, earth or ice as packing materials.

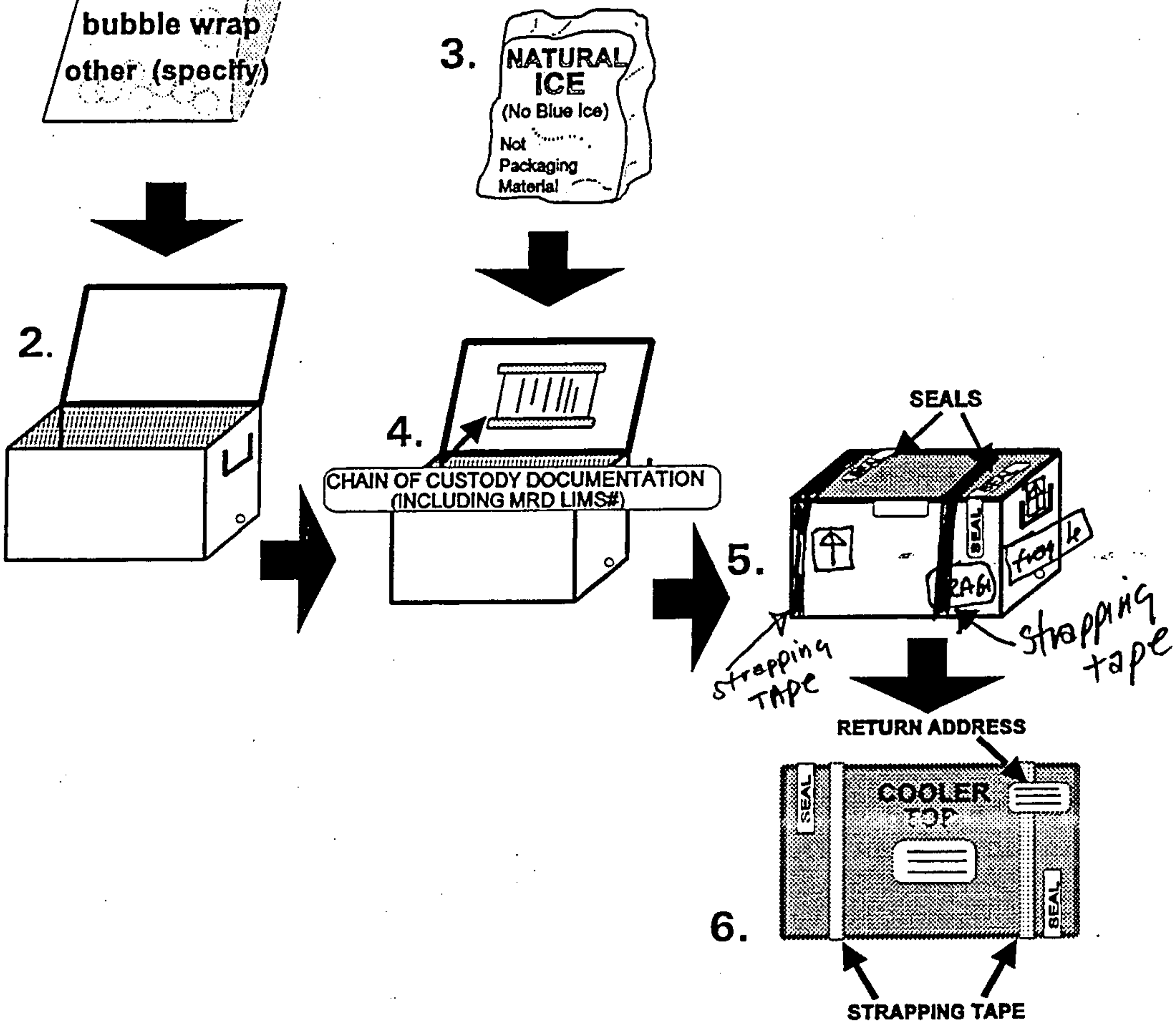
3. Using ice sealed in double plastic Zip-lock bags place on top of sample containers.

4. Enclose chain of custody form in a sealed plastic bag. Tape plastic bag to inside top of cooler.

5. Close cooler and seal with custody seals. Place clear tape over custody seals.

6. Use strapping tape to secure cooler and vent port.



| | | |
|---|---|---|
| PROJECT | SECURITY SEAL | ID # |
| / / | CENTER | |
| DATE | SECURITY SEAL | SIGNATURE OF COLLECTOR |

**U.S. ARMY CORPS OF ENGINEERS**

**CHAIN OF CUSTODY RECORD**

**LABORATORY INFORMATION**

Name:__________
Address:__________

Phone:__________

Fax:__________

NCB POC:__________

Project Name/Number:__________

Project Phase__________

LIMS#__________

Sheet # 00001

| Sample ID | Additional Information | Sample Matrix | Date/Time Collected | EPA Container # of | EPA Container Type | VOC | SVOC | Pesticides/PCBs | Metals | Cyanide | | | | | | Preservation? (e.g; temperature, chemical) | Health / chemical hazard ? | Method # | Tag # |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | S | | 2 | D | X | | | | | | | | | | | | 8260 | 1 |
| | | | | | | X | | | | | | | | | | | | | 2 |
| | | | | 1 | G | | X | | | | | | | | | | | 8270 | 3 |
| | | | | 1 | G | | | X | | | | | | | | | | 8081 | 4 |
| | | | | 1 | G | | | | X | | | | | | | | | 6000/7000 | 5 |
| | | | | 1 | G | | | | | X | | | | | | | | 9013 | 6 |
| | | W | | 3 | B | X | | | | | | | | | | | | 8260 | 7 |
| | | | | | | X | | | | | | | | | | | | | 8 |
| | | | | | | X | | | | | | | | | | | | | 9 |
| | | | | 2 | H | | X | | | | | | | | | | | 8270 | 10 |
| | | | | | | | X | | | | | | | | | | | | 11 |
| | | | | 2 | H | | | X | | | | | | | | | | 8081 | 12 |
| | | | | | | | | X | | | | | | | | | | | 13 |
| | | | | 1 | C | | | | X | | | | | | | | | 6000/7000 | 14 |
| | | | | 1 | C | | | | | X | | | | | | | | 9012 | 15 |

**To be initiated by sample collector & completed as necessary thereafter.**

| Relinquished by: (Signature/Print) | Date/Time | Received by: (Signature/Print) | Date/Time | Purpose of Change/Remarks |
|---|---|---|---|---|
| 1 | | | | |
| 2 | | | | |

| For internal use only | Job# | Scheduled completion date | Laboratory contact person | Extension# |
|---|---|---|---|---|

SAMPLE COOLER RECEIPT FORM

LIMS #______

Contractor Cooler________

QA Lab Cooler: ________

Number of Coolers:______

PROJECT:______________________________ Date Received:______________

USE OTHER SIDE OF THIS FORM TO NOTE DETAILS CONCERNING CHECK-IN PROBLEMS

A. PRELIMINARY EXAMINATION PHASE: Date cooler was opened: ________

by (print) ____________________ (sign) ______________________________

1. Did cooler come with a shipping slip (air bill, etc.) ? ________ YES NO

   If yes, enter air bill number here: ______________________________

2. Were custody seals on outside of cooler? ________ YES NO

   How many and where?__________ Seal Date ________ Seal name ______

3. Were custody seals unbroken and intact at the date and time of arrival?______ YES NO

4. Did you screen samples for radioactivity using the Geiger Counter?______ YES NO

5. Were custody papers sealed in a plastic bag & taped inside to the lid? ______ YES NO

6. Were custody papers filled out properly (ink, signed, etc.) ?________ YES NO

7. Did you sign custody papers in appropriate place?________ YES NO

8. Was project identifiable from custody papers? If YES, enter project name at top YES NO

9. If required, was enough ice used?______ a. Type of ice:________ YES NO

   b. Cooler temperature________

10. Have designated person initial here to acknowledge receipt of cooler ______ Date________

B. LOG-IN PHASE: Date samples were logged in:______________

by (print)____________________ (sign) ______________________________

11. Describe type of packing in cooler: ______________________________

12. Were all bottles sealed in separate plastic bags? ________ YES NO

13. Did all bottles arrive unbroken & were labels in good condition?________ YES NO

14. Were all bottle labels complete (ID, date, time, signature, preservative, etc.)? ____ YES NO

15. Did all bottle labels agree with custody papers?________ YES NO

16. Were correct containers used for the test indicated?________ YES NO

17. Were correct preservatives added to samples?________ YES NO

18. Was sufficient sample sent for tests indicated?________ YES NO

19. Were bubbles absent in Volatiles samples? If so, list by QA #__________ YES NO

20. Was project manager called/ status discussed? If yes, give details/back of form YES NO

21. Who was called?__________ By whom? __________ Date: __________